Schistosomiasis (Bilharzia) in Madagascar: A Case Study of a Neglected Tropical Disease

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Schistosomiasis (Bilharzia) in Madagascar:

A Case Study of a Neglected Tropical Disease

Sarah Grace Sawyer
Schistosomiasis (Bilharzia) in Madagascar:  
*A Case Study of a Neglected Tropical Disease*

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December 04, 2013

**Abstract:**

Over 50% of Madagascar’s population is infected with intestinal or urinary schistosomiasis (Rollinson et al., 2012). The disease slowly debilitates infected persons, who are frequently children, resulting in lower productivity and reduced learning in school-age children. The disease involves a vicious cycle perpetuated by a number of environmental, psychological, and social factors. A multifaceted approach, involving mass treatment, biological control, environmental control, education, and disease surveillance, can lead to schistosomiasis control and elimination in Madagascar. This would yield many socio-economic benefits such as increased productivity, increased school attendance rates, and generally better welfare. Schistosomiasis is the most burdensome and deadly neglected tropical disease (CDC, 2011). Furthermore, it is second only to malaria as the most devastating parasitic disease in the world (The Carter Center, 2012). Schistosomiasis is a public health problem in Madagascar and many other countries. It is treatable, curable, and preventable, and a multifaceted approach can stop the harmful impact it is having on communities.
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Morondava
December 2013
“Although the world is full of suffering, it is full also of the overcoming of it. My optimism, then, does not rest on the absence of evil, but on a glad belief in the preponderance of good and a willing effort always to cooperate with the good, that it may prevail.”

—Helen Adams Keller
# Table of Contents

Title Page and Abstract .......................................................................................................................... 2
Acknowledgements ..................................................................................................................................... 3
Foreword ...................................................................................................................................................... 4
Table of Contents ....................................................................................................................................... 5
Introduction .................................................................................................................................................. 6
  Introduction and Relevance .......................................................................................................................... 6
  Purpose and Intent ...................................................................................................................................... 6
  Thesis ......................................................................................................................................................... 7
  Methodology and Ethical Considerations ..................................................................................................... 7
  Obstacles and Biases ................................................................................................................................. 8
Study Area: Morondava and the Menabe Region ......................................................................................... 9
  Modern Historical Background of Madagascar ........................................................................................... 9
  Public Health in the Context of Madagascar .............................................................................................. 10
  Morondava and the Menabe Region: Background Information ................................................................. 11
Schistosomiasis: Background Information ................................................................................................. 12
  A Brief History ........................................................................................................................................ 12
  The Impact Worldwide ............................................................................................................................ 12
  The Pathological Perspective .................................................................................................................... 13
  Transmission .......................................................................................................................................... 14
  Symptoms .............................................................................................................................................. 14
  Diagnosis .............................................................................................................................................. 15
  Treatment ............................................................................................................................................. 16
  Prevention and Control ............................................................................................................................. 17
The Public Health Impact ............................................................................................................................. 17
  The Vicious Cycle ................................................................................................................................... 17
  Analysis: The Vicious Cycle ..................................................................................................................... 19
  Lack of Treatment and the Reinfection rate ............................................................................................... 19
  Analysis: Lack of Treatment and the Reinfection rate ........................................................................... 20
  Impact on Productivity and School Attendance ..................................................................................... 21
  Analysis: Productivity and School Attendance ....................................................................................... 21
The Dissemination of the Disease:
  Environmental, Social, and Psychological Factors .................................................................................... 22
  Stagnant Water: Heavy Rains and Poor Drainage ................................................................................... 22
  Lack of Latrine Usage and Lack of Education ......................................................................................... 24
  Direct Contact with Schistosomiasis in Daily Life ................................................................................... 25
  Hospitals: Far Away and Out of Budget .................................................................................................... 26
  Little to No Support from the Ministry of Health .................................................................................... 27
Schistosomiasis Control in Madagascar: The Agenda for Elimination ......................................................... 28
  Mass Treatment ................................................................................................................................. 28
  Snail Control ....................................................................................................................................... 29
  Stagnant Water Control .......................................................................................................................... 30
  Education ............................................................................................................................................. 31
  Surveillance for the Long Term ................................................................................................................ 32
Schistosomiasis: The Broader Perspective ................................................................................................. 32
  The Global Perspective on Schistosomiasis ............................................................................................. 32
  Other Prevalent Tropical Diseases in Madagascar .................................................................................. 33
Analysis: The Situation as a Whole ............................................................................................................ 34
Suggestions ................................................................................................................................................ 35
Conclusion .................................................................................................................................................. 36
Appendix I: Glossary of Terms and Acronyms ......................................................................................... 38
Appendix II: Figures .................................................................................................................................... 41
  Figure 1: (Map) Schistosomiasis Risk Worldwide ..................................................................................... 41
  Figure 2: (Table) Schistosomiasis Prevalence in Sub-Saharan Africa ..................................................... 42
  Figure 3: (Image) The Intermediate Hosts: Snails ................................................................................... 43
  Figure 4: (Diagram) The Life Cycle of Schistosomiasis ......................................................................... 44
  Figure 5: (Map) The Menabe Region ....................................................................................................... 45
  Figure 6: (Photograph) Stagnant Water in Antsirabe-Maroaloka ............................................................... 46
Bibliography ............................................................................................................................................... 47
Introduction

Introduction and Relevance

Schistosomiasis is an immense public health problem in Madagascar. Over 50% of the country’s population has this parasitic infection, with even more at risk of infection (Rollinson et al., 2012). The disease slowly debilitates infected persons, who are frequently children, resulting in lower productivity and reduced learning in school-age children. The disease involves a vicious cycle perpetuated by a number of environmental, social, and psychological factors. The good news is that schistosomiasis is entirely treatable, curable, and preventable. A multifaceted approach, involving mass treatment, biological control, environmental control, education, and disease surveillance, can lead to schistosomiasis control and eventual elimination in Madagascar. In addition, schistosomiasis is a global disease, with 240 million infected people worldwide (CDC, 2011). Approximately 90% of these infections are in Africa (Rollinson et al., 2012). The Centers for Disease Control and Prevention estimates that 700 million people are at risk for infection in 74 countries (CDC, 2011). Schistosomiasis is the most burdensome and deadly neglected tropical disease, a term signifying a disease that receives less attention than other killers such as malaria and HIV/AIDS (CDC, 2011). Furthermore, it is second only to malaria as the most devastating parasitic disease in the world (The Carter Center, 2012). Schistosomiasis is a public health problem in Madagascar and many other countries. It is treatable, curable, and preventable, and a multifaceted approach can stop the harmful impact it is having on communities.
**Purpose and Intent**

This study is worth conducting because schistosomiasis is a major public health problem in Madagascar, affecting a large percentage of the population. My intent for this study was to explore the public health impact of the disease on affected and at-risk communities. I also intended to explore approaches to eliminating the disease, taking into account the environmental, social, and psychological factors that aid in schistosomiasis’ propagation. Furthermore, I intended to dig deeply into the concept of neglected tropical diseases. Schistosomiasis is considered the most harmful neglected tropical disease, killing hundreds of thousands of people each year in Africa alone, even though the disease is treatable, curable, and preventable (CDC, 2011). Schistosomiasis, in particular, could be eradicated using straightforward techniques. My purpose was to look closely at schistosomiasis’ public health impact, and describe an approach to elimination, relying only on proven techniques, that would yield significant societal benefits and improve people’s lives.

**Thesis**

Schistosomiasis involves a vicious cycle that negatively affects people’s lives, the economy, and children’s education in Madagascar. It can be eliminated through a multifaceted approach for disease elimination. Ultimately, the benefits from elimination will be immense.

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i See Appendix II, Figure 1: “Schistosomiasis Risk Worldwide,” p. 41
Methodology and Ethical Considerations

For this study, I used primary and secondary sources. I interviewed many doctors, nurses, and hospital technicians about schistosomiasis. I asked questions regarding the impact of the disease, as well as the best route to elimination. All of my interviews were conducted at private hospitals and the Centre de Santé de Base II (CSB II) in Morondava. I had originally planned to conduct field work at the large public hospital in Morondava, but unfortunately this did not work out due to an objection from the hospital director. This did not pose a problem for collecting information. Furthermore, I did not interview any schistosomiasis patients in Morondava because of impracticality. Most often, schistosomiasis patients are not hospitalized, and many do not even come to the hospital. Because of the nature of schistosomiasis, it was almost impossible to find patients under a doctor’s care in the city of Morondava.

However, to obtain better context for my study, I conducted a field visit to a rural village called Antsirabe-Maroaloka, which is located twenty kilometers north of Morondava. I interviewed one person who was infected with schistosomiasis, and another villager who I talked with about public health and water resources in the village. While this one field visit proved very valuable, ideally I would have conducted many more. Given the scope of a four-week long study, I did not have enough time or resources to do this.

In terms of ethical considerations, all interviewees were asked for their consent to participate in this study. It was made clear that all participation was voluntary, and remaining anonymous was an option. In addition, all medical professionals signed consent forms before their interviews.
Obstacles and Biases

I encountered several obstacles and biases while conducting this study. First, I was not able to conduct any field work at the large public hospital in Morondava. This ruled out many doctors and nurses who could have provided valuable information regarding schistosomiasis in Morondava. I was able to work around this, and still obtained excellent information from interviews that I conducted at other medical facilities. Second, there is less attention paid to schistosomiasis in Madagascar than other diseases such as HIV/AIDS, malaria, and tuberculosis. As a result, I encountered no organizations or associations that focus on schistosomiasis control in Morondava; hospitals, clinics, and my village field visit were my only resources.

In addition, I recognize that there are biases present in my field work. Because I mostly interviewed medical professionals, I obtained information from people who are typically not at risk for schistosomiasis infection, because they live in an urban area and are educated on what precautions to take to prevent schistosomiasis. As a result, they may have given answers that did not entirely represent the situation. For example, they may have suggested ideas for a solution that were ideal, but perhaps somewhat impractical.

In order to have avoided these biases, I would have had to conduct a broader range of field work, which was out of the scope of this study.

Study Area: Morondava and the Menabe Region

Modern Historical Background of Madagascar

Madagascar was a French colony from 1896-1960, and is one of the least developed countries in the world. The current government is transitional, following the coup d’etat in 2009,
where current president Andry Rajoelina took power from former president Marc Ravalomanana. The current government is not recognized by many other countries, including the United States of America. On October 22nd, 2013, Madagascar held the first election since the 2009 coup d’état. In late December 2013, there will be a second round of the election, in which there will be a run-off between two candidates. The election this fall, if recognized as free and fair, could lead to more international aid.

Public Health in the Context of Madagascar

The Ministry of Public Health in Antananarivo, the nation’s capital, is responsible for public health duties and information in Madagascar. The ministry directs all public hospitals and health centers, as well as the financing of public health programs. Public health programs may include missions to rural areas (e.g. The National Leper Program), health education in schools and communities, treatment programs, and crisis response (e.g. to an epidemic). Public health programs depend on finances, and currently there are more public health problems than the available finances can handle. The Ministry of Health’s two biggest concerns are the health of pregnant mothers and children under five (A. Ranaivo, personal communication, November 15, 2013). There are a number of public health initiatives taking place within non-governmental organizations, such as Population Services International (PSI), and governmental organizations such as the United States Agency for International Development (USAID). Madagascar faces many public health problems, and schistosomiasis is not the deadliest. Malaria and tuberculosis are prevalent, and more devastating than schistosomiasis in Madagascar.
Morondava and the Menabe Region: Background Information

I conducted this study in Morondava, which is a small coastal town in the Menabe region on the west coast. Because of the hot climate and many isolated villages surrounding Morondava, schistosomiasis is highly prevalent in the urban periphery and more rural areas. Unfortunately, it was out of the scope of my study to conduct extensive field work in an isolated, rural village where schistosomiasis rates are high. Morondava was a better choice for a place to stay because I was able to conduct field work with medical professionals who are knowledgeable about schistosomiasis in the Menabe region.

In Morondava, there is one public hospital, Centre de Hospitalier de Reference (CHR), a public health clinic, Centre de Santé de Base II (CSB II), and several private hospitals and clinics. The private establishments included SALFA-Betela Lutheran Hospital, Dispensaire Catholique, and several small private practices. There are also health related NGOs, such as PSI, that have a presence in Morondava. The medical resources are much less extensive in Morondava than in other cities in Madagascar, such as in Antananarivo. In rural areas outside of Morondava, the medical resources are even sparser. There are CSBs that cover large areas, and often these clinics are a long walk from many villages. The CSBs in the Menabe region’s rural areas most often do not have the same diagnostic tools and treatment as the hospitals in Morondava have. Furthermore, there are typically only one or two doctors present at each CSB, compared to the many doctors at hospitals in Morondava. For many medical situations, people must come to Morondava for diagnosis and treatment.
Schistosomiasis: Background Information

A Brief History

The schistosomiasis haematobium parasite was discovered in 1851 by Theodore Bilharz, a German surgeon working in Cairo, Egypt (Ahmed, 2013). The parasitic infection thus was named bilharzia, and has been referred to as snail fever, or by its more scientific parasitic name, schistosomiasis.

The Impact Worldwide

Schistosomiasis has a worldwide impact, affecting hundreds of millions of people each year, with even more at risk of the infection. The Centers for Disease Control and Prevention estimated that 700 million people are at risk in 74 countries, 240 million people are already infected, and there are 280,000 schistosomiasis related deaths in Africa each year (CDC, 2011).ii Approximately 90% of schistosomiasis infections worldwide occur in Africa (Rollinson et al., 2012). Schistosomiasis is considered a neglected tropical disease, meaning that it has less international attention than other big killers like malaria. However, schistosomiasis is the most burdensome neglected tropical disease, with the most number of people at risk and infected. (CDC, 2011). Over 50% of the Madagascar’s population is infected with schistosomiasis, with most of the infections occurring in rural areas (Rollinson et al., 2012). Of the five countries with the highest schistosomiasis infection rates, all are in Africa: in order they are Mozambique, Ghana, Sierra Leone, Tanzania and Madagascar (Rollinson et al., 2012).iii Schistosomiasis is also present in southern Asia, the Middle East, and South America, but the infection rates range from

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ii See Appendix II, Figure 1: “Schistosomiasis Risk Worldwide,” p. 41

iii See Appendix II, Figure 2: “Schistosomiasis Prevalence in Sub-Saharan Africa,” p. 42
very low to almost zero. The highest infection rate outside of Africa is in Yemen with a rate of 14.4%, and other non-African infection rates are typically under 5% (Rollinson et al., 2012).

**The Pathological Perspective**

Schistosomiasis infection is caused by one of six different parasites: S. mansoni, S. japonicum, S. mekongi, S. guineensis, S. intercalatum, or S. haematobium (WHO, 2013). The first five aforementioned parasites cause intestinal schistosomiasis, and the S. haematobium parasite causes urinary schistosomiasis (WHO, 2013). The S. mansoni and S. haematobium parasites are the most common worldwide, and are the two present in Madagascar (WHO, 2012). The S. mansoni parasite is present in the east and south regions in Madagascar, whereas S. haematobium is present in the north and west regions, including the Menabe region (WHO, 2012). Both S. mansoni and S. haematobium are present in some areas of the central highlands (WHO, 2012). Schistosomiasis exists everywhere in Madagascar except in the most northern tip, specific areas of the northeastern coast, and specific areas of the central highlands near Antananarivo (WHO, 2012). It can be presumed that schistosomiasis will eventually travel to these areas with the incidence of rural to urban migration, as long as there is no schistosomiasis control program in Madagascar. Remarkably, the schistosomiasis lifecycle has evolved to require two hosts: humans, plus specific species of snails that live in stagnant water. The snail hosts are different for the different schistosomiasis parasites. The host for S. haematobium, the parasite present in the Menabe region, is Bulinus obtusispria (WHO, 2012). Before inhabiting the snails, the parasite lays eggs in fresh, stagnant water, and larvae hatch from the eggs. The larvae then

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*See Appendix II, Figure 3: “The Intermediate Hosts: Snails,” p. 43. Although Bulinus obtusispria is not included in this image, it shows select other snails which the schistosomiasis parasites infect.*
infect specific species of snails, grow in the snail, and eventually release a different type of larvae into the water. These larvae search for human skin, which they penetrate, later turning into worms in the intestines, liver, or bladder of the human body. The worms lay eggs that continue to cause harm, and either get released in human feces, in the case of S. mansoni, or urine, in the case of S. haematobium (The Carter Center, 2012).^1

**Transmission**

Humans acquire schistosomiasis by contact with stagnant water containing the parasites, which penetrate human skin. In Madagascar, the disease is most often acquired through swimming or bathing in stagnant water, children playing in infected water, doing laundry in infected water, working in rice fields, or fishing (J. Rajaonarivelo, personal communication, November 13, 2013). Infection can occur with a short amount of exposure to schistosomiasis infected water. Once the parasite larvae matures into worms in the organ that it is infecting, it starts releasing eggs in either human feces (intestinal schistosomiasis) or urine (urinary schistosomiasis) (The Carter Center, 2012). When infected persons defecate or urinate in stagnant bodies of water (e.g. lakes, ponds, stagnant rivers), the eggs are released, and search for snails to infect (The Carter Center, 2012). The process is started all over again.

**Symptoms**

Schistosomiasis symptoms, which are caused by the worm’s eggs, can range from non-existent to acute during the beginning phases of the disease (WHO, 2013). The disease is not

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^1 See Appendix II, Figure 4: “The Life Cycle of Schistosomiasis,” p. 44
completely debilitating, but slowly deteriorates the health of the infected person, and can eventually lead to death (F. Ranaivoson, personal communication, November 12, 2013).

Symptoms of intestinal schistosomiasis include intestinal pain, diarrhea, blood present in stool, and liver and spleen enlargement in late stages of the disease (WHO, 2013). Symptoms of urinary schistosomiasis include hematuria (blood present in urine), damage to bladder and kidney, and bladder cancer in late stages of the disease (WHO, 2013). In late stages of the disease, children experience severe anemia and stunted growth (Ahmed, 2013). In women, urinary schistosomiasis can cause genital lesions, vaginal bleeding, pain during sexual intercourse, and infertility (WHO, 2013). (While often called urinary schistosomiasis, it also causes symptoms in the genital area, so many researchers prefer the name ‘urogenital schistosomiasis’). Furthermore, urinary schistosomiasis makes men and women more susceptible to HIV and other sexually transmitted infections (STIs) (Kjetland, Leutscher, & Ndhlovu, 2012). The lesions around the eggs in the genital area provide an easy entry point for HIV (Kjetland et al., 2012). In addition, if someone is infected with both schistosomiasis and HIV, there is a greater risk for transmission of HIV to one’s partner, because there are higher HIV levels in genital ulcers (Kjetland et al., 2012). In late stages of schistosomiasis, the worms can travel to the brain, causing a cerebral infection. This causes deliriousness and eventual death.

**Diagnosis**

Diagnosis for schistosomiasis includes a urine test for urinary schistosomiasis, or a fecal test for intestinal schistosomiasis (R. Razanamampionona, personal communication, November 12, 2013). Diagnosis may also include an ultrasound to assess damage done to organs; especially
the intestines, liver, spleen, and bladder. In the Menabe region, diagnosis is available at the hospitals and clinics in Morondava, and costs about 20,000 Ariary, which at 2013 exchange rates equals about US$10. (N. Raozaba, personal communication, November 18, 2013). From Morondava, the hospital sends the sample to the Pasteur Institute of Madagascar in Antananarivo for serologic analysis and official diagnosis of the presence of schistosomiasis eggs in the sample (N. Raozaba, personal communication, November 18, 2013).

**Treatment**

Treatment for schistosomiasis, whether intestinal or urinary, is Praziquantel\(^{vi}\) which is an inexpensive, safe drug that in one dosage will reverse the infection and its symptoms (Knackmuss, 2008). The drug is on the list of WHO’s most essential medicines, and is used to prevent schistosomiasis in at-risk populations as well as for treatment (Knackmuss, 2008).\(^{vii}\) In the Menabe region, one dose of Praziquantel for schistosomiasis treatment costs about 500 Ariary (about US$0.25) (N. Raozaba, personal communication, November 18, 2013). For advanced schistosomiasis infection, other treatments may be necessary. Patients may receive treatment for severe anemia, and possibly antibiotics for other infections present due to schistosomiasis (V. Raharivonimalala, personal communication, November 14, 2013). Compared to other diseases in Madagascar and worldwide, schistosomiasis treatment is straightforward.

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\(^{vi}\) Praziquantel’s generic name is Biltricide.

\(^{vii}\) Praziquantel was developed by Merck and Bayer in collaboration with WHO thirty years ago. In 2008, Merck donated 6 million Praziquantel tablets to school children in Nigeria, Benin, and Madagascar. The Merck-Praziquantel program is supposed to continue for ten years, through 2017, to provide 200 million tablets (worth 80 million USD) to 27 million school-age children in at-risk communities (Knackmuss, 2008). It is unclear if this program is still running, or if it is still running in Madagascar. It is not running currently in the Menabe region.
**Prevention and Control**

Prevention of schistosomiasis infection would be simple, if there were no environmental, social, and psychological factors at work. These other factors will be addressed later in the paper. In a perfect world, prevention involves eliminating contact with infected water. This means no swimming, bathing, doing laundry, playing, working, or fishing in stagnant water where snails and the parasites live. With a comprehensive approach involving treatment of infected persons, snail control, stagnant water control, and behavioral control, schistosomiasis can be dramatically reduced and ultimately eliminated.

**The Public Health Impact**

**The Vicious Cycle**

Schistosomiasis is endemic in rural areas of the Menabe region (R. Razanamampionona, personal communication, November 12, 2013). Some districts in the area have particularly high rates of urinary schistosomiasis, namely Malaimbandy, Belo-Tsiribihina, Mandabe, Miandrivazo, and Befasy (J. Rajaonarivelo, personal communication, November 13, 2013). These are districts are farther away from Morondava, and many are north of the city. These are rural areas where there is no access to JIRAMA water, and people must use rivers, lakes, and ponds for everyday chores such as bathing and laundry (M. Herinjatovo, personal communication, November 14, 2013). In addition, people have direct contact with the disease in their work, such as rice farming or fishing. In January and February there are heavy rains (and cyclones), and

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viii See Appendix II, Figure 5: “The Menabe Region,” p. 45
ix JIRAMA is the national water and electricity company in Madagascar.
x The schistosomiasis parasite also infects snails in the flooded rice fields.
combined with bad drainage in the fields, the run-off causes many channels, small lakes, and
ponds (A. Ranaivo, personal communication, November 15, 2013). The disease keeps
propagating because people urinate in the bodies of water, passing on the parasite’s eggs, and
starting the cycle all over again. Because of the huge amounts of stagnant water, the fact that
people do not have access to non-infected water, and the fact that people use the water as a
latrine, the rates of schistosomiasis are extremely high. “There is a mass infestation of
parasites”\textsuperscript{xi} in many rural villages (V. Raharivonimalala, personal communication, November 14,
2013). Dr. Andrinjara Ranaivo, the head doctor at the CSB II in Morondava, estimated that
upwards of 90% of villagers in the periphery of Morondava are infected with schistosomiasis (A.
Ranaivo, personal communication, November 15, 2013). In addition, schistosomiasis travels.
With rural to urban movement, the infection is moving inward toward the central highlands of
Madagascar (Ollivier, Brutus, & Cot, 1998). Lastly, there is little education about the disease.
People often mistake hematuria (blood present in urine), the most common symptom of urinary
schistosomiasis, for a sexually transmitted infection, and do not know which precautions to take
to prevent infection (R. Razanamampionona, personal communication, November 12, 2013).
Because people mistake the hematuria symptom as a STI, they are often scared to go to the
doctor because of stigmas attached to STIs (R. Razanamampionona, personal communication,
November 12, 2013). With all these factors combined, a vicious cycle occurs where
schistosomiasis infections lead to even more infections. Without control, the infection rate will
remain in the vicinity of 100%.

\textsuperscript{xi} Original quotation: “Il y a une infestation en masse des parasites.”
**Analysis: The Vicious Cycle**

Schistosomiasis in the Menabe region is endemic, with an infection rate close to 100% because of a multitude of factors contributing to the disease’s success. Some factors are specific to rural areas, such as no access to JIRAMA water, and direct contact with the disease in one’s work: rice farming in infected rice fields, or fishing in an infected lake. People have no way of avoiding the parasite, unless they stop functioning on a day-to-day basis, which is unrealistic. Breaking a vicious cycle like this requires a multifaceted approach. Later in this paper I will further analyze the vicious cycle of schistosomiasis infection, and suggest solutions.

**Lack of Treatment and the Reinfection rate**

In order to receive diagnosis and treatment, infected persons must travel to Morondava. Getting to Morondava may involve several hours or days of travel from the village, and most often people only come to the hospital for the most serious cases (M. Ralisom, personal communication, November 18, 2013). Once at the hospital, most people can neither afford the diagnosis nor the treatment (N. Raozaba, personal communication, November 18, 2013).xi If they can afford it, a urine sample (or fecal, in the case of intestinal schistosomiasis in other areas of Madagascar) is taken and sent for analysis to the Pasteur Institute of Madagascar in Antananarivo. If patients do get treated, they most often get reinfected upon return to their village, and they may return to the hospital in a few months for another round of treatment (N. Ralafiarindaza, personal communication, November 14, 2013). A general practitioner at SALFA-

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xii In the Menabe region, diagnosis is about 20,000 Ariary (10 USD) and treatment is about 500 Ariary (25 cents in USD).
Betela Lutheran Hospital, Dr. Victorine Raharivonimalala, said that even though she tells schistosomiasis patients how to avoid schistosomiasis in the future, she sees very high rates of reinfection because people cannot avoid the disease (V. Raharivonimalala, personal communication, November 14, 2013). The nature of the villagers’ work, rice farming and fishing, involves direct contact with schistosomiasis, and “they must work” (V. Raharivonimalala, personal communication, November 14, 2013). Furthermore, infection rates have been rising since the 2009 political crisis, because of its economic consequences, making people less able to pay for diagnosis and treatment (N. Raozaba, personal communication, November 18, 2013).

*Analysis: Lack of Treatment and the Reinfection rate*

The lack of treatment and the high reinfection rate, sometimes immediately following the original treatment, illustrates the persistent public health impact schistosomiasis has on communities. Not only does it perpetuate itself in a vicious cycle, but the tools being used to help the situation are not helping for long as people are either not getting treated or getting reinfected. The infection has a large impact on the Menabe region and Madagascar as a whole, because a high percentage of the population is suffering from the disease. People are not receiving treatment because hospitals are far away and the diagnosis and treatment is unaffordable. This is a reflection of the medical facilities in Madagascar as a whole; given the size of the population, there are too few clinics and doctors. People have little help from the government, local organizations, or medical establishments in Morondava, in controlling the disease and its public

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xiii Original quotation: “Ils doivent travailler.”
health impact. As a result, the disease continues to affect huge numbers of people in the Menabe region, and will continue to do so unless and until a comprehensive control agenda is established.

**Impact on Productivity and School Attendance**

Because of the debilitating nature of schistosomiasis, productivity rates are lower for adults and school attendance is lower for children. The most common symptom with urinary schistosomiasis in the Menabe region is hematuria (blood present in urine) and pain, which makes children stay home from school and adults not work (H. Razapinoramisa, personal communication, November 13, 2013). The disease can be immobilizing, and the symptoms cause people to not follow their daily routine. As the infection progresses, symptoms worsen, and people become more debilitated, lessening their ability to work or attend school.

**Analysis: Productivity and School Attendance**

Worsened productivity and school attendance rates show that the public health impact of the disease goes beyond just painful symptoms: it has a socio-economic impact as well. A nurse at the CSB II in Morondava, Monsieur Joseph Ralisom, said that in his opinion, “first, there is an economic impact” from schistosomiasis in the Menabe region. Public health problems have many consequences beyond negatively affecting people’s lives. Elimination of schistosomiasis would yield socio-economic benefits. When a community is at risk for schistosomiasis infection, it is much harder to reduce rural poverty (King & Dangerfield-Cha, 2008). Schistosomiasis also needs to be taken into account when thinking about rural development because many development-
oriented projects (e.g. water infrastructure projects, and improving farming practices) affect, and are affected by, schistosomiasis.

The Dissemination of the Disease:
Environmental, Social, and Psychological Factors

The Ideal Climate for Parasites

The climate in Madagascar, and specifically in the Menabe region, is ideal for parasite growth, including schistosomiasis and many other parasites such as hookworm. The sandy soil, as well as dirty stagnant water, makes an ideal habitat for many parasites. In the Menabe region, there are heavy rains and the possibility of cyclones in January and February each year. This causes a lot of water run-off, leading small channels or ponds to form. The rains in January and February increase the schistosomiasis parasite population, causing an influx of cases in those two months (A. Ranaivo, personal communication, November 15, 2013). Climate is one reason why schistosomiasis thrives in Madagascar, however it is not the only reason.

Stagnant Water: Heavy Rains and Poor Drainage

In addition to the heavy rains, there is poor drainage and irrigation in rural areas in the Menabe region, which exacerbates the problem of water run-off (Wilson et al., 1987). The water table is often very high as a result of irrigation, which leads to pools and ditches filled with stagnant water (Wilson et al., 1987). These places are habitats for the schistosomiasis intermediary hosts, snails, and thus also for the S. haematobium parasites. The fact that there is a surge of schistosomiasis cases during the rainy season, January and February, suggests improved
drainage would significantly reduce schistosomiasis cases (A. Ranaivo, personal communication, November 15, 2013). In addition, there is a lot of stagnant water present due to all the rice fields. The Menabe region, like much of Madagascar, produces a large rice crop.\textsuperscript{xv} Rice requires a lot of water, as well as a flooded field for part of the season. This is also a habitat for snails, and thus for the S. haematobium parasites.

To witness the problem of stagnant water, I visited a rural village called Antsirabe-Marcoaloka, which is about twenty kilometers north of Morondava. There were several small ponds in the vicinity of the village, and many shallow areas that would fill up with water during the rainy season. These ponds and lakes had some salt in them because of the proximity to the coast, however schistosomiasis still exists, because the salt content is not high enough to kill the snails and parasites. Furthermore, many of the ponds were formed from the rice field irrigation run-off. There were water channels running along the road, and many culminated in a pool of stagnant water. Because of heavy rains and poor drainage in the fields, there is a lot of stagnant water present in the Menabe region, which increases greatly during the rainy season. In the vicinity of the village, I saw a young woman walking to wash laundry in one of the lakes, and a few children cooling off in a pool of water near a rice field. Another man stopped to wash his hands and arms in the water channel beside the road. This field visit demonstrated the amount of stagnant water in rural areas as well as the multiple ways people come in contact with it.

\textsuperscript{xv} The primary food in Madagascar is rice. In 2011, Madagascar produced 4.3 million tons of rice, a decrease from past years (IRIN: Humanitarian News and Analysis, 2011).
Lack of Latrine Usage and Lack of Education

Another factor contributing to schistosomiasis propagation is the lack of latrine usage and lack of education surrounding the disease. It is customary for Sakalava people\(^{xvi}\) to urinate and defecate in bodies of water or the forest. Dr. Andrinjara Ranaivo at the CSB II in Morondava says that it is not the Sakalava custom to use latrines, and they think using them is bad for their health (A. Ranaivo, personal communication, November 15, 2013). As a result, urinary schistosomiasis continues to be spread. The schistosomiasis eggs are released in the urine, and when an infected person urinates in a body of stagnant water, the disease cycle begins all over again (The Carter Center, 2012). According to Dr. Ranaivo, USAID started a program for latrine construction and education in 2012, which has been helpful, but requires more work (A. Ranaivo, personal communication, November 15, 2013). Latrine usage is critical in stopping urinary schistosomiasis in the Menabe region, because it interrupts the transmission of the disease. Latrine usage is also a crucial step in stopping transmission of intestinal schistosomiasis, which is propagated via human feces.

In addition, there is a general lack of education about schistosomiasis in affected communities and among medical personnel. In one interview I conducted, a medical professional stated beliefs contradicted by more than ten other interviewees. The medical professional said that CSBs in rural areas surrounding Morondava have schistosomiasis drug treatments (Praziquantel) in stock, and that villagers do not need to come to Morondava for diagnosis and treatment (Anonymous, personal communication, November 18, 2013). Although this is just one

\(^{xvi}\) The Sakalava people are an ethnic Malagasy group originating on a part of the west coast, including the Menabe region.
case, it shows that there is a lack of information about schistosomiasis control and the situation at hand.

*Direct Contact with Schistosomiasis in Daily Life*

In rural areas in the Menabe region, most villagers have direct, unavoidable contact with schistosomiasis. Most villagers work as farmers, and rice growing is the most common form of agriculture, as rice is the primary food source for Madagascar. The schistosomiasis parasites infect snails which live in the flooded rice fields; they then release schistosomiasis larvae that penetrate human skin. Rice farmers and fishermen have direct, unavoidable contact with schistosomiasis on a daily basis. It is preposterous to suggest that villagers must change their livelihoods in order to prevent schistosomiasis. Instead, the parasite must be eliminated from rice fields, and steps must be taken to prevent reinfection. Furthermore, children ages 4-14 are some of the most prone to schistosomiasis infection because they play in infected ponds and lakes (R. Razanamampionona, personal communication, November 12, 2013). Because of the large amount of stagnant water, it is impossible to stop children from playing in the water. Moreover, this is a common play activity for children, perhaps because of a lack of other toys and games. Other direct contact activities include washing clothes, which is done in the water for lack of alternatives. Everyone is affected by schistosomiasis (except perhaps infants), and often, the contact is daily and unavoidable.

A twenty year old villager in Antsirabe-Maroloka, who was infected with schistosomiasis, said in an interview that he knew that using water from the ponds is bad, but he
Another older villager in Antsirabe-Maroaloka said that he knows schistosomiasis exists in the well he uses for water (Anonymous, personal communication, November 23, 2013). People get sick with schistosomiasis and other water borne diseases such as diarrhea, but there is no clean water source to prevent this (Anonymous, personal communication, November 23, 2013). The disease is unavoidable.

**Hospitals: Far Away and Out of Budget**

Yet another factor of schistosomiasis dissemination is the fact that hospitals are a long distance away for many people. People in the Morondava periphery must come to Morondava for schistosomiasis diagnosis and treatment, which can mean a journey of up to hundreds of kilometers (M. Ralisom, personal communication, November 18, 2013). Most often, infected persons only come to the hospital when their symptoms are severe (M. Ralisom, personal communication, November 18, 2013). When people do come to the hospital, they often can afford neither the diagnosis nor the treatment (N. Raozaba, personal communication, November 18, 2013). Furthermore, sometimes urinary schistosomiasis symptoms are mistaken for a sexually transmitted infection, and embarrassment discourages people from coming to the hospital (R. Razanamampionona, personal communication, November 12, 2013). Other times, when the disease is advanced and has turned into cerebral schistosomiasis, people seek out treatment from a spiritual doctor because of delirium (A. Ranaivo, personal communication, November 15, 2013).

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xvii See Appendix II, Figure 6: “Stagnant Water in Antsirabe-Maroaloka,” p. 46
The twenty year old villager in Antsirabe-Maroloka, who was infected with schistosomiasis, said that he doesn’t seek out treatment because “there is no money”\textsuperscript{xviii} (Anonymous, personal communication, November 23, 2013). A ten year old boy, who also had schistosomiasis, accompanied the young man to the interview. The boy’s shorts were blood stained, which the young man said was from the blood present in the boy’s urine (hematuria). The young man said he knew that schistosomiasis is a bad disease, and that people in his village have died from it because they can’t afford treatment.

\textit{Little to No Support from the Ministry of Health}

There is currently no specific support for schistosomiasis control from the Ministry of Public Health in Antananarivo. Previously, the Ministry of Public Health worked with Merck in 2008 to provide Praziquantel to school-age children (Knackmuss, 2008). However, the program has not continued, and more focus is put on other diseases, such as malaria, HIV/AIDS, tuberculosis, leprosy, and most recently, the black plague (A. Ranaivo, personal communication, November 15, 2013). Apart from a disease focus, the Ministry of Public Health’s top priority is programs for the most vulnerable: pregnant women and children under five years of age. Arguably, the aforementioned concerns are of greater importance than schistosomiasis because they have higher mortality rates. Schistosomiasis is not a priority for many governments because, although debilitating, people live with the disease for a long time. This perspective perpetuates the epidemic of schistosomiasis in Madagascar (A. Ranaivo, personal communication, November 15, 2013).

Schistosomiasis control in Madagascar should include the ultimate objective of eradicating the disease. First and foremost, this will improve peoples’ lives. It will also have socio-economic benefits such as higher productivity and higher school attendance rates. Schistosomiasis control is an important step in development, particularly in rural areas. Without schistosomiasis control, reducing rural poverty is more difficult (King & Dangerfield-Cha, 2008). Control consists of mass treatment, snail control, stagnant water control, education, and schistosomiasis surveillance. Below I explain each of these facets of schistosomiasis control.

Mass Treatment

According to most medical professionals I interviewed in my field study, mass treatment is the most important element of successful schistosomiasis control. Mass treatment must occur in every at-risk community in Madagascar. For it to be effective, mass treatment cannot just occur in one village or district. With rural to urban movement, it is important to have a national program for mass treatment, otherwise the infection will return quickly with people traveling from one place to the next. Mass treatment should be targeted at school-age children, rice farmers, and fishermen. Mass treatment means treating everyone who is infected or at-risk in the community. In villages that have infection rates in the vicinity of 90%-100% (like in the case of many communities in the Menabe region), it would be more cost effective to treat everyone. However, a different strategy should be considered for other regions in Madagascar where the infection rate is lower. No schistosomiasis vaccine exists, so it is not possible to prevent the

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xix See Appendix I, Public Health Terms: schistosomiasis control, elimination, and eradication for definitions.
disease in one person with medical treatment. The treatment must be free, considering the fact that many people are unable to pay for diagnosis or treatment. Mass treatment controls schistosomiasis in the short term, and improves peoples’ lives. In addition, it decreases transmission of the parasite, which is a crucial step toward elimination.

_Snail Control_

Attention must also be paid to the intermediate hosts, snails, in the multifaceted schistosomiasis control agenda. A doctor at the Catholic clinic in Morondava said that, “the snails must be eliminated first”xx (C. Raoiliharison, personal communication, November 13, 2013). This removes a step in the schistosomiasis life cycle, reducing the parasite’s population. Another medical professional at SALFA-Betela Lutheran Hospital in Morondava suggested introducing ducks who eat the snails, which would in turn reduce the parasite population (P. Rakotoarivelo, personal communication, November 14, 2013). Another medical professional at the CSB II in Morondava suggested that schistosomiasis larvae-eating ducks should be introduced (J. Ralisom, personal communication, November 18, 2013). Another option is introducing competitor snails, but this requires more research on which types of snails to introduce (Rollinson et al., 2013). In addition, there has been some research on mullusciciding (snail elimination) with the chemical niclosamide, which has proven to be effective at killing both snails and schistosomiasis larvae (Rollinson et al., 2012). However, niclosamide kills fish, has a negative environmental effect, requires repeated use to prevent snails from returning, and is expensive (Rollinson et al., 2012). Thus, niclosamide is not an appropriate option for

xx Original quotation: “Premièrement, les mollusques doit éliminer.”
schistosomiasis control in Madagascar, as it could do more harm than good. Snail control is an important facet of schistosomiasis control as it interrupts a part of the schistosomiasis life cycle, thus helping to reduce rates of infection.

**Stagnant Water Control**

Stagnant water plays a large role in the vicious cycle of schistosomiasis. Poor drainage and irrigation, in combination with heavy rains, results in a lot of stagnant water, where schistosomiasis parasites live. Water development and infrastructure projects need to take schistosomiasis control into account, in regards to drainage, water run-off, and stagnant bodies of water that snails thrive in (Steinmann, Keiser, Bos, Tanner, & Utzinger, 2006). Land-filling (e.g. of small ponds) and improved drainage can have a huge effect on schistosomiasis control, because it destroys some of the largest snail habitats (Wilson et al., 1987). It is difficult to control schistosomiasis in rice fields, but some stagnant water control goes a long way. A doctor at SALFA-Betela Lutheran Hospital in Morondava suggested that tall boots be provided to rice farmers to protect against schistosomiasis infection (R. Razanamampionona, personal communication, November 12, 2013).

There must be monitoring in future water projects, because of the importance of good drainage and irrigation to prevent huge amounts of water run-off. Control of stagnant water is a crucial facet of the schistosomiasis control agenda as it interrupts the parasite’s life cycle.
Education

Education about schistosomiasis, leading to changes in behavior, is also important in the agenda for schistosomiasis control. This is another common recommendation from the medical professionals I interviewed in my field study. An anonymous interviewee said that during the Merck Praziquantel program a couple years ago, parents were very worried about their children taking the medicine at school, and many parents didn’t accept it (Anonymous, personal communication, November 18, 2013). There was and is a lack of understanding about the disease and its diagnosis and treatment. Education is crucial so people know what precautions to take to avoid schistosomiasis, and why.

This facet of schistosomiasis control also involves latrine construction and education. An important step in stopping schistosomiasis is encouraging the usage of latrines. When infected people urinate in stagnant rivers, lakes, and ponds, schistosomiasis eggs are released, and the disease cycle is perpetuated. Latrine usage stops transmission of both urinary and intestinal schistosomiasis transmission. Education to encourage use of latrines is perhaps the most difficult factor in schistosomiasis control, because it involves a behavior change. Sakalava people in specific believe latrines are bad for their health, and they are not accustomed to using them (A. Ranaivo, personal communication, November 15, 2013). In 2012, USAID started a program for latrine education, which has been helpful, but it is a challenging project (A. Ranaivo, personal communication, November 15, 2013). Programs like this need to continue in communities at risk for schistosomiasis. Education about the disease and behavior change is an important facet of schistosomiasis control, leading the way to disease elimination.
Surveillance for the Long Term

Finally, for schistosomiasis elimination, there needs to be long term surveillance. Surveillance involves not only monitoring for a new outbreak, but continuing stagnant water control, education, snail control, and perhaps mass treatment in the shorter term. A medical professional at SALFA-Betela Lutheran Hospital said “there needs to be a public health mission organized for schistosomiasis because it is a dangerous disease” (P. Rakotoarivelo, personal communication, November 14, 2013). With long term surveillance, elimination efforts can get to the point where socio-economic benefits increase exponentially. The vicious cycle of schistosomiasis infection becomes replaced by a virtuous cycle of productivity, higher school attendance rates, better education, a growing economy, further infrastructure development, and so on.

Schistosomiasis: The Broader Perspective

The Global Perspective on Schistosomiasis

Schistosomiasis exists almost everywhere in Madagascar. It also is highly prevalent in other parts of Africa, and exists in some other countries in Southern Asia and South America. The Centers for Disease Control and Prevention estimated that 700 million people are at risk in 74 countries, 240 million people are already infected, and there are 280,000 schistosomiasis related deaths in Africa each year (CDC, 2011). Madagascar has the fifth highest rate of schistosomiasis in the world (Rollinson et al., 2012). The reality is that schistosomiasis is not just a public health issue in Madagascar, but in many other countries as well. There needs to be an

xxi Original quotation: “Il faut organiser une mission de la bilharziose parce que c’est une maladie dangereuse.”
African control initiative for schistosomiasis, especially focusing on countries like Madagascar, where schistosomiasis affects more than half the population (Rollinson et al, 2012).

**Other Prevalent Tropical Diseases in Madagascar**

Madagascar faces many public health problems, and schistosomiasis is only one of them. Arguably, diseases such as malaria, tuberculosis, and HIV/AIDS pose greater risks because they have higher mortality rates. There are also many other parasitic infections present, such as hookworm. There is a risk of other epidemics, such as cholera, which last occurred in Madagascar in the year 2000. Schistosomiasis causes great harm and is a burdensome public health issue, but it is only one of many.

**Neglected Tropical Diseases**

Schistosomiasis is a neglected tropical disease, meaning that it gets less international attention because it is not as prevalent or as fatal as many other tropical diseases. Malaria is the world’s most deadly tropical disease, but schistosomiasis ranks second in terms of worldwide public health impact (The Carter Center, 2012). Other neglected tropical diseases include Dengue Fever, Guinea Worm Disease, African Sleeping Sickness, and Trachoma (CDC, 2011). More attention needs to be paid to neglected tropical diseases, including schistosomiasis. Public health initiatives will reduce incidences of neglected tropical disease, improving peoples’ lives, and yielding significant socio-economic benefits.
Analysis: The Situation as a Whole

Schistosomiasis is a public health problem in Madagascar, affecting huge numbers of people living in rural areas. Both the Ministry of Public Health as well as outside organizations need to pay more attention to schistosomiasis control in Madagascar. The good news is that with effort, schistosomiasis can be controlled effectively and ultimately eliminated. Money is not the only problem with schistosomiasis control efforts in Madagascar. With any public health issue, there are a multitude of environmental, psychological, and social factors that contribute to the disease’s dissemination. In order for schistosomiasis control to be successful, there needs to be careful attention paid to all facets of the public health issue. This includes examining behavior patterns and attitudes about using latrines, beliefs about the disease, children’s play patterns, peoples’ reluctance to get a diagnosis, environmental factors such as heavy rains, water infrastructure, and more. Without looking all the facets, control is ineffective and elimination impossible. The Menabe region offers an excellent case study of schistosomiasis in Madagascar, because the rates of infection are so high in the urban periphery and rural areas. More research needs to be done with infected persons and field studies need to be conducted in rural areas, not just in Morondava. Medical professionals offer excellent information about the disease, as they are educated about schistosomiasis and other tropical diseases. However, field studies need to be conducted in the infected areas, outside of the more urban environments where medical professionals typically work. Theory suggests one thing, but reality may suggest another. A multifaceted approach, including mass treatment, snail control, stagnant water control, education, and long term surveillance, is the key to schistosomiasis control and elimination in Madagascar. Correctly done, this will lead to improving peoples’ lives, as well as improving productivity,
school attendance rates, sanitation, and overall health. Schistosomiasis control is an important step in rural development in Madagascar, and in other countries that face the presence of schistosomiasis.

**Suggestions**

Schistosomiasis control requires financial backing. If the government of Madagascar had enough money to devote to schistosomiasis, they could have public health missions for the disease. Unfortunately, such funding doesn’t exist, especially since the recent 2009 political crisis that has had a negative economic impact on the country. Funding agencies need to step in. Possible major funders include USAID, PSI, DFID, The Carter Center, Merck, WHO, and UNICEF. Other smaller projects could be financed by smaller organizations. If schistosomiasis control is initiated in Madagascar, there will be many benefits. First and foremost, peoples’ lives will be bettered, and HIV/AIDS infection rates may be reduced. There will also be many socio-economic benefits such as higher productivity and higher school attendance rates in rural areas. Funding agencies must realize that schistosomiasis control in affected areas can be a major accelerator to rural development, and could strengthen Madagascar’s presence in the global economy.

In addition, a public health mathematical model for schistosomiasis control should be developed. A similar schistosomiasis control mathematical model is cited in a study conducted on schistosomiasis in western China. The authors state that a mathematical model can help determine exactly how much each environmental, social, and psychological factor affects the disease’s perpetuation (Liang et al., 2007). Furthermore the study found that a schistosomiasis
control mathematical model can provide a basis for determining how much money and effort should be put forth for each facet of the schistosomiasis control strategy (Liang et al., 2007). A similar public health mathematical model should be produced for Madagascar to optimize schistosomiasis control, and to determine how each facet of the control strategy should be approached. The model should take into account each factor in the dissemination of the disease; specifically, the environmental, social, and psychological factors that perpetuate the disease. If this is done, schistosomiasis control in Madagascar will be successful and lead to the disease’s eventual elimination from the country. Similarly, if a model is formed for other countries where schistosomiasis is prevalent, there is a road towards schistosomiasis eradication worldwide.

**Conclusion**

Schistosomiasis is a major public health problem in Madagascar. Over 50% of the country’s population is infected with this parasitic infection, with even more at risk of infection (Rollinson et al., 2012). The disease slowly debilitates infected persons, who are often children, resulting in lower productivity and reduced learning in school-age children. Schistosomiasis involves a vicious cycle, where a multitude of factors perpetuate the disease’s transmission in rural communities in Madagascar. Many people do not get diagnosed or treated for the infection because of lack of ability to pay or lack of hospitals. Furthermore, if treatment does occur, the reinfection rate is high because of the inability to avoid the disease. People, including children, often have direct contact with schistosomiasis in their daily lives. Because of the infection, productivity and school attendance rates are lowered, with significant socio-economic harm. Schistosomiasis requires a multifaceted solution for control and ultimately elimination. The
solution must take into account all the factors that perpetuate the disease: lack of treatment, huge amounts of stagnant water, presence of snails, lack of education about the disease, lack of latrine usage, and lack of infection surveillance. The solution requires mass treatment, snail control, stagnant water control, education, behavior change, and surveillance, for it to be effective in the long term. Rather than being a neglected tropical disease in Madagascar, schistosomiasis should be addressed, yielding significant long-term benefits.
Appendix I: Glossary of Terms and Acronyms

Public Health Terms:

- **Neglected Tropical Diseases**: A group of parasitic and bacterial infections that affect over one billion people living in chronic poverty worldwide (CDC, 2011).

- **Schistosomiasis Control**: The act of lowering schistosomiasis prevalence. This action requires surveillance to sustain itself (Rollinson et al., 2012).

- **Schistosomiasis Elimination**: Reducing schistosomiasis incidences to zero in a specific geographical region. Surveillance is required to prevent the infection from being re-introduced (Rollinson et al., 2012).

- **Schistosomiasis Eradication**: Reducing schistosomiasis incidences to zero permanently worldwide. No surveillance is required (Rollinson et al., 2012).

Medical Terms:

- **Bilinus obtusispria**: The snail intermediary host that the parasite S. haematobium seeks out to infect.

- **Hematuria**: The presence of blood in urine.

- **Lesion**: A part of an organ or tissue that is damaged due to injury or disease. Examples include abrasions, wounds, ulcers, or abscesses.

- **Serology**: The medical diagnostic study of bodily fluids, including urine and blood.

- **S. haematobium**: The schistosomiasis parasite that causes urinary/urogenital schistosomiasis, and that is present in the Menabe region.

- **S. mansoni**: The schistosomiasis parasite that causes intestinal schistosomiasis.

- **Praziquantel**: The medicine used for schistosomiasis treatment, developed by Merck and Bayer in collaboration with WHO thirty years ago (Knackmuss, 2008).
Public Medical Facilities in Madagascar:

- **CHR**: (Centre Hospitalier de Reference) Malagasy public hospitals offering many medical services, including laboratory work and hospitalization.

- **CSB**: (Centre de Santé de Base) Malagasy basic health centers, termed either level “I” or “II,” signifying the services they have. CSB IIs have an additional maternity and delivery ward. CSBs typically have one or more doctors on staff.

Organizations:

- **NGO**: Non-governmental Organization.

- **The Carter Center**: An NGO based in Atlanta, Georgia, dedicated to improving human rights and reducing human suffering (The Carter Center, 2013).

- **CDC**: (Centers for Disease Control and Prevention) The United States’ health protection agency, dedicated to protecting America from health, safety, and security threats, both in the U.S. and in foreign countries (CDC, 2013).

- **PSI**: (Population Services International) A global health organization working to create healthier lives in the developing world. Major focuses include family planning, HIV/AIDS, maternal health, health of children under five years of age, malaria, diarrhea, pneumonia, and malnutrition (PSI, 2013).

- **SALFA**: (Sampan’Asa Loterana momban’ny Fahasalamana) A Malagasy health organization created by the Malagasy Lutheran church in 1979, and dedicated to reducing infant mortality, tuberculosis, leprosy, HIV/AIDS, and many other health issues (SALFA, 2013).

- **USAID**: (United States Agency for International Development) An agency of the United States’ government, working to carry out U.S. foreign policy through health, economic, good governance, agriculture, environment, education, conflict resolution, and humanitarian assistance projects in the developing world (USAID, 2013).


- **DFID**: (Department for International Development) A ministerial department of the United Kingdom’s government, dedicated to ending extreme poverty in developing countries (DFID, 2013).

**Relevant Madagascar Terms:**

- **Ariary**: The Malagasy currency. In 2013 exchange rates, 2000 Ariary is roughly 1 USD.

- **Menabe region**: A region in Madagascar located on the west coast. The city of Morondava is located in this region.

- **Sakalava people**: The Malagasy ethnic group originating on a part of the west coast, including the Menabe region.
Appendix II: Figures

Figure 1: Schistosomiasis Risk Worldwide
Source: The World Health Organization, 2012
<table>
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<th>Country</th>
<th>Total population (thousands) in 2010</th>
<th>Estimated country prevalence (%) of schistosomiasis in mid-2003</th>
<th>Control programme</th>
<th>Population infected in 2010</th>
<th>Reported number of people treated in 2010</th>
<th>National treatment coverage (%) in 2010</th>
<th>Estimated country prevalence (%) of schistosomiasis in 2010</th>
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Figure 3: The Intermediate Hosts: Snails
Source: The World Health Organization, 2012

Although the snail that *S. haematobium* (urinary schistosomiasis) infects, Bulinus obtusispria, is not pictured above, this image shows other examples of snail hosts that other schistosomiasis parasites infect.
The Life Cycle of Schistosomiasis

Schistosomiasis affects more than 200 million people worldwide. The parasitic larvae live in fresh water and can penetrate human skin, placing people at risk through everyday activities such as washing laundry or fetching water. Inside the victim’s body, adult female worms lay thousands of eggs that cause significant damage to internal organs, most commonly from scarring the intestines, bladder, kidneys, liver, or lungs. Children suffer the most from schistosomiasis, which causes poor growth and impaired cognitive function. The disease is completely preventable and can be controlled through an annual inexpensive drug treatment, health education, and access to safe water and sanitation.
Figure 5: The Menabe Region
Source: Google Maps
A pond near the village of Antsirabe-Maroaloka, on the periphery of Morondava. This pond will fill up to become a small lake during the rainy season. It is a source of drinking water, and is also used for laundry, bathing, fishing, and a play area for children. The pond is infected with schistosomiasis, but villagers have no other choice for water. Note the water bottle with holes on the bottom to filter out rocks and algae.
Bibliography


