

## **Vector-Borne Water Related Diseases in Sub-Saharan Africa Refugees**

### **Background**

This year, 2008, is deemed at the “International Year of Sanitation” by the World Health Organization. This goes in line with the first Goal of the UN Millennium Development Goals of “eradicating extreme poverty and hunger”. Over 1.1 billion people worldwide do not have access to safe drinking water (WHO and UNICEF 2006). This directly leads to the death of 1.6 million children under the age of five each year (WHO). This produces a huge burden from diseases and parasites like diarrhea, ascariis, dracunculiasis, hookworm, schistosomiasis, trachoma, and intestinal worms to name a few, which could be prevented with proper drinking water and improved sanitation.

The goal of the UN is to reduce the number of people that don't have safe drinking water by half by the year 2050. Statistics show that this goal is reachable still, though we are somewhat lagging in achieving this. The main problems are rapid urbanization and huge rural populations.

The Sub-Saharan Africa region is by far the worst affected by lack of safe drinking water. Between the years of 1990 and 2004, the number of people without access to clean water increased by 23% in this region. Refugees are among the most vulnerable populations world wide for a variety of reasons including their general demographic makeup, comprised of 80 percent women and children, as well as their displacement status. This population is even recognized officially by the United Nations as being vulnerable and therefore is given certain protections under UN law (UNHCR, 1951). There are 9.2 refugees and 25 million displaced persons in the world as of 2006, 30% of whom are found in Sub-Saharan Africa. As the Sub-Saharan Africa region has the worst overall access to clean drinking water and refugees are considered to among the most vulnerable population in the world, I thought it would be interesting to study vector-borne water related diseases which result from contact and/or ingestion of contaminated water (Yike, 2008).

### **Vector-borne diseases in Sub-Saharan African refugees**

For the focus of this paper I choose to look solely at water vector-borne diseases, thereby excluding water-borne diseases such as cholera, typhoid fever, diarrhea etc. Though these produce a high mortality rate, length restrictions forced me to limit the scope. The vector-borne diseases associated with water that are discussed in detail include malaria, onchocerciasis, schistosomiasis, and dracunculiasis. Sub-Saharan Africa is more affected by each of these illnesses then any other region of the world. In fact, dracunculiasis has been eradicated from everywhere but Africa. Africa is region hosing the second most number of refugees worldwide, perhaps the most vulnerable group of people, yet suffering worst from vector-borne water diseases. I believe that it is important to highlight this and the need for continuing research and intervention.

### **Malaria**

Malaria is the most deadly vector borne disease, a huge problem worldwide, with 40% of the global population at risk for malaria (WHO, 2007; WHO, 2008). 500 million people contract malaria each year, and 1 million of these die (WHO, 2007). Children are especially at risk for death due to malaria, and children within the Sub-Saharan region have the highest average number of malaria fever per year, ranging between 1.6 and 5.4 events depending of the region (WHO, 2007). As a result of this high incidence rate one in every five childhood deaths in Sub-Saharan Africa is caused by malaria, with a child dying every 30 seconds (WHO, 2007). Pregnant women are also at high risk for malaria which has very serious consequences in this population including 60% fetal loss as well as causing 10% maternal deaths (WHO, 2007). The environmental presence of open water sources which provide mosquito breeding grounds and moving from an area of no malaria risk to one of high malaria risk are among the highest risk factors for contracting malaria.

The malaria parasite can be transmitted to humans as any one of the following four pathogens *falciparum*, *P. vivax*, *P. ovale* and *P. malariae* (CDC, 2004). The first two are the most common in the Sub-Saharan Africa region. These pathogens can live in humans and female *Anopheles* mosquitoes. The human thus acts as the host, with the mosquito acting as the vector by becoming infected while sucking blood from an infected human. The cycle of infection continues as the infected mosquito contaminates the next human it feeds on. The pathogen is more likely to survive within the mosquito if high temperatures and high humidity are present. Once the parasite has entered the human host it grows and multiplies in the liver cells, after which it continues to grow in the red blood cells and begins to release daughter parasites which then invade other red blood cells (CDC, 2004). At this stage the subject begins to exhibit symptoms, which may include fever, sweating, headaches, chills, nausea and vomiting, general malaise, and body aches (CDC, 2006). However, malaria symptoms are far more severe in children, pregnant women, and persons without resistance to the disease (CDC, 2006). Symptoms of this can include loss of consciousness, seizures, anemia, hemoglobinuria, pulmonary edema, acute respiratory distress syndrome, cardiovascular collapse, and even acute kidney failure (CDC, 2006).

Refugees and displaced persons have high risk for malaria and are an especially vulnerable population for this disease due to a wide variety of reasons. Perhaps one of the most obvious is the mere population makeup, with 45% of the 33 million displaced persons in the Sub-Saharan region comprised of children. Although adults are also at risk for contracting malaria, children are far more likely to develop severe malaria and die of the disease (WHO, 2007). Another clear reason for high malaria risk in refugee camps, especially at the early stage of setting up the camp is the lack of health services and control programs which would have been long established in a permanent setting (Rowland, 2001). With displacement often made to temporary camps with inadequate water facilities in place, the storage of water by the refugees in open containers also creates increased risk for malaria as water storage containers provide a new breeding ground for the mosquito population (Plianbangchang, 2005). The potential displacement of refugees from areas with little to no malaria threat to areas of high malaria

concentration also serves to increase the vulnerability of refugees to malaria, especially if these had no former exposure and therefore no immunity (Rowland, 2001). Lack of protective shelters and medication are the final criteria that make refugees highly vulnerable for malaria especially when their camps are at their beginnings and not yet well settled and established.

There are many different types of interventions that have been tried in dealing with malaria. Some general ones include removing standing water, providing bed nets, spraying with insecticide, and chemoprophylaxis. A PubMed search produced several articles that showed successful intervention strategies specifically within Sub-Saharan refugees.

Two articles were found that looked at using insecticide treated bed nets to reduce malaria prevalence, and both of these studies were conducted in Ugandan refugee camps. The first was a case-control study where 37 home shelters were proofed against mosquitoes and 18 were not (Medlock, 2007). The number of blood-fed mosquitoes/person/night was significantly higher in the control group compared with the treatment group of residents with proofed shelters. Multivariate analysis showed that the difference in biting rates was directly related to the mosquito proofing. The second study design was cross-sectional and included 1245 individuals from 835 households. The results from this study showed decreased risk of mosquito bites and malaria in households where the bed nets were used (Spencer, 2004). Proofing homes with insecticide-treated nets is cost-effective and seems to significantly reduce the risk of malaria within the Sub-Saharan refugee population. I would recommend it a top priority intervention step for dealing with malaria in the refugee camps.

Another study using dealing with malaria prevention in 5 refugee camps in Sudan looked at the effects of indoor spraying with malathion on malaria (Charlwood, 2001). This case-control trial consisted of comparing the rates of malaria between five refugee camps where the homes of the refugees were sprayed vs. malaria rates of five control refugee camps where no spraying was done. Mortality rate due to malaria was lower in the intervention camps for three months following spraying, but the incidence of malaria was found to be the same in cases and controls. As a result, I am not sure whether I would recommend spraying based on this study and would recommend that more research as to the benefit of spraying be done in a similar cross-sectional fashion to further explore potential benefit.

The fourth malaria prevention study identified studied the impact of the use of insecticide treated clothing as a tool. The study was conducted in Kenya refugee camps with 197 participants that were randomized to receive the treatment insecticide permethrin or water sprayed onto their clothes. Laboratory blood tests were used to detect malaria pre and post intervention, and spraying of insecticide onto the clothes of the refugees was shown to reduce malaria infection by 70 percent. Thus I would also recommend using insecticide sprayed clothing, however I do so with hesitation as there was no information provided as to whether there is any health risk associated with daily close exposure / skin exposure for humans to the pesticide used to treat the clothing.

In conclusion, the most prevalent and water vector-borne disease malaria can be reduced in Sub-Saharan refugee camps through simple and inexpensive means, including providing mosquito nets, the use of insecticide treated clothes, and perhaps spraying malathion. I would recommend the implantation of these in that order for the sake of proven effectiveness as well as cost. Although several interventions have proven successful for reducing malaria rates, I would recommend that more research be done on trying to understand why malaria eradication programs have not been very successful in Sub-Saharan Africa as they have in other regions of the world. Since eradication has proven possible elsewhere, I think that focusing research work on understanding the weaknesses of the programs that have failed to lead to this in Sub-Saharan Africa may allow for future corrections in these which could eventually lift the malaria burden from the region for good.

### **Onchocerciasis**

Onchocerciasis is the second most common cause of blindness worldwide, with 18 million persons infected worldwide (WHO, 2008). An overwhelming majority of the cases are located in the Sub-Saharan Africa region. It is caused by the parasite *onchocerca volvulus* which breeds in water. It takes one to three years for any symptoms to being to appear after infection. Symptoms consist of intense itching, skin depigmentation, lymphadenitis, and visual problems with potential blindness (WHO, 2008). Before interventions were begun in the 1970's, over 50% of the adult age population in rural West Africa suffered from Onchocerciasis. Fortunately, after 30 years and over half a billion dollars of investment into prevention and treatment in Africa the number of infected people is now 6.5 million worldwide (WHO, 2008).

Onchocerciasis is caused by the nematode parasite *Onchocerca volvulus*. This worm can survive for up to 14 years in the human body (WHO, 2008). Transmission from an infected person to a healthy person is a result of the blackfly. The blackfly, which lives and mates near fast flowing rivers, feed on human blood after mating. When biting an infected person, the blackfly ingests worm larva, which it then transmits to the next person it bites (WHO, 2008). These microscopic worms grow and mature within the infected persons to a length of up to half a meter for the female worms. The worms migrate to the fibrous nodes and stay close to the skin surface within the human body. The female worms then breed and produce millions of microscopic worms, which are then ingested by the blackfly in continuing the spread of the disease. The microscopic worms die causing severe itching and depigmentation of the skin of the infected usually within three years (WHO, 2008). Hanging groins can result if the worms migrate to the groin region and blindness can occur if the worms migrated reaching the eyes.

Refugees may be at high risk for Onchocerciasis based on region of resettlement. Resettlement from a region where Onchocerciasis was not an issue due to lack of fast moving water to one where it is prevalent puts refugees at high risk for infection as they may know little about the existence of the disease and how to try to guard against it compared to a native population from the area. An observational study done in Ethiopia

shows that resettlement of a population from a high terrain area where Onchocerciasis was not prevalent to a river valley resulted in 0.9% of the refugees contracting Onchocerciasis (Kloos, 1991). Males are also at greater risk for contracting Onchocerciasis, probably a result of greater exposure to the blackfly while performing outdoor activities than the women who are more confined to the housing settlement. Another study done in a displaced population in Cameroon identified that the rainy season is the peak of transmission, that the larva breeding sites are located on seasonal streams and that farming close to these seasonal streams posed a high risk for Onchocerciasis within the resettled population (Quillevere, 1990). This suggests that refugees may be at greater risk for contraction than the native population because of lack of awareness as to when/where not to farm, knowledge which the local population may be aware of from experience.

The rates of Onchocerciasis have decreased substantially since the 1970's. Two different methods of interventions have typically used for dealing with Onchocerciasis. The first involves prevention through the spraying of the breeding sites of the blackflies with the goal of killing the larva before they mature. The second intervention is done in persons who have already contracted Onchocerciasis and is comprised of administration of the drug ivermectin, Mectizan, which kills the young worms before they grow extensively and cause even more damage and relieves the intense itching that is a primary symptom of Onchocerciasis (WHO, 2008). The Onchocerciasis Control Program in West Africa is one of the most successful disease control efforts in Africa. It was began in 1973 as a program sponsored by the World Bank, The United Nations Development Program, the UN Food and Agricultural Organization, and the World Health Organization (WHO, 1998). As of 1998, it was estimated that this program prevented 40 million Africans from becoming infected and permitted 25 million hectares of land to be used from agriculture (WHO, 1998).

There is now adequate and efficient know ways of preventing and treating Onchocerciasis. However, the Onchocerciasis Control Program come to a near stand still in the early 2000's. Since Onchocerciasis has not fully been wiped out from Africa, there is fear that regions that have been rid of the disease may be re-infected at a later date. As blackflies are also still found in the region, one case of Onchocerciasis could trigger a new cycle of re-infection with the flies then moving around the area and further perpetuating the problem. Furthermore, refugees may still be at higher risk for contraction of Onchocerciasis because they are often settled in regions that may not have undergone the Onchocerciasis clearing scheme since these regions are not normally densely inhabited by the local population. I would recommend that an Onchocerciasis surveillance program be used in at risk areas to monitor for potential outbreaks. This surveillance could be more cost effective if it was also simultaneously monitoring the region for other disease outbreaks, such as malaria.

### **Schistosomiasis**

Schistosomiasis is a huge health issue in several regions of the world including Sub-Saharan-Africa. 200 million people are currently infected and another 650 million are a

risk worldwide. 80% of these live in the Sub-Saharan Africa region (WHO/TDR, 2004). Schistosomiasis is caused by trematode flatworms. The subtypes *Schistosomah haematobium*, *Schistosomah mansoni*, and *Schistosomah mekongi* cause either urinary or intestinal Schistosomiasis, and are found in different regions of Sub-Saharan Africa (WHO, 2008). Schistosomiasis is transmitted by freshwater snails which release the parasite into the water. This larva infects humans through penetration of the skin. Schistosomiasis causes chronic illness with severe long term effects. Urinary Schistosomiasis is manifested through blood in the urine, and can develop into bladder cancer and kidney problems (WHO, 2008). Intestinal Schistosomiasis is characterized by a variety of symptoms of which only some may be present in the infected individual. Symptoms include diarrhea, abdominal pain, tiredness, abdominal discomfort, and blood in the feces (WHO, 2008). Long term affects are serious liver and spleen complications due to the buildup of parasitic eggs (WHO, 2008).

Schistosomiasis is transmitted due to the freshwater snail. An infected person expels the parasitic eggs through urine and feces which, in cases of lacking sanitation, drain into the fresh water source. The eggs hatch in the fresh water releasing miracidia larva, which need to infect a specific type of fresh water snail in order to reproduce (WHO, 2008). Each snail can accommodate the production of thousands of new larvae, which are the released into the water as cercariae larvae (WHO, 2008). The cercariae penetrate the human skin entering the bloodstream of the infected. 30-40 days after infection the cercariae grows to become a long worm which moves into the intestine in intestinal Schistosomiasis or bladder in Urinary Schistosomiasis (WHO, 2008). If the worm is female it will lay 200 to 2000 eggs each day for 5 years. Half of the eggs remain trapped in the growing tissue of the liver or spleen, which are trying to grow in an effort to heal themselves, and half of which are excreted through the urine and feces, thereby again beginning the cycle.

Women, children, and fishermen/irrigation workers have the highest risk rate for Schistosomiasis. This is because children often swim and play in lakes and channels, having high skin exposure over prolonged periods of time (WHO, 2008). Women are also high risk due to occupational hazard as they are the ones responsible for getting water and washing dishes and clothes (WHO, 2008). Therefore as 80% of refugees are comprised of women and children, this population automatically has a higher risk for Schistosomiasis contraction. A study of refugees relocated to the US from Somali show 2 out of 390 refugees to suffer from Schistosomiasis (Miller, 2000). However, this number is probably low due to health checkups required before migration to the US is permitted. Several case studies were found from Australia and the US identifying Sub-Saharan refugees suffering from Schistosomiasis. Some include a 32 year old male refugee from Somali relocated to Wisconsin (Neal, 2004), a 13 year old Librarian refugee to New York (Olson, 2006). However, one of the most impressive findings as to the severity of Schistosomiasis illness in child refugees comes from a study done on 3800 Sudanese and 8000 Somalian refugee children to the US (Posey, 2007). Of the 462 Sudanese child refugees tested 44% were found to have Schistosomiasis (Posey, 2007). 73% of the 100 Somalian refugee children tested found to have Schistosomiasis (Posey, 2007). These rates are extremely alarming and point out the fact that refugee children are

at especially high risk for Schistosomiasis, and may be at greater risk depending on their region of origin. Unfortunately, no studies were found identifying the rates of Schistosomiasis for refugees relocated to regions in Sub-Saharan Africa. However, I would estimate this rate to be even higher, as exposure to Schistosomiasis no longer exists after relocation to Australia or the US, whereas exposure risk often continues in the area of relocation in refugees remaining in the region.

Schistosomiasis is a water vector born disease often associated with development projects such as the building of dams and irrigation, which may put people at increased risk to exposure to the freshwater snail which acts at the intermediate host for Schistosomiasis (WHO/TDR, 2004). Once the Schistosomiasis has reached the granuloma stage, the damage it caused is irreversible even though the worm may be killed (WHO, 2008). Since re-infection is common in people living in areas of high transmission risk, regular treatment for Schistosomiasis will keep the number of worms in a persons body low enough to prevent severe damage (WHO, 2008). Drug treatment is available in the form of oxamniquine to kill the Schistosomah mansoni worm type, or praziquantel, which kills all Schistosomah subtypes (WHO/TDR, 2004).

Prevention is a key focus of Schistosomiasis control, with the focus on elimination of the intermediate host, the fresh water snail. The chemicals molluscicides are used to kill the snails (WHO/TDR, 2008). Installation of piped water supply with a pump, wells with taps, and proper latrines reduces exposure to Schistosomiasis. The lining of irrigation channels with concrete is a more expensive, but long lasting way to reduce Schistosomiasis. This clearance of cannels would also help with the other water vector-born illnesses addressed by this paper, including the most prevalent – malaria.

I would recommend that Schistosomiasis continue to be treated in two distinctive components in the refugee camps. First, I would recommend that the water be treated with molluscicides, a easy and relatively inexpensive way to help with prevention. However, knowing how vulnerable the refugee population is, if the camp is located in an area with a high rate of Schistosomiasis infection, I would recommend that all refugees also be given praziquantel tablets. Since internal damage caused by the buildup of parasitic eggs cannot be reversed and serious internal damage and death can occur due to infection, I believe that it would be in the best interest of the camp that all receive treatment. One dose of praziquantel costs a mere US \$0.08 (WHO, 2008), so this second preventive effort for high risk areas would not be cost prohibited. However, if cost is an issue, prioritization among the refugee population needs to be made to woman and children who are most at risk for developing Schistosomiasis, which in any case tend to make up 80% of the refugee population. Other control measure such as cleaning and concreting the water canals may be to expensive to undertake. Despite their effectiveness in dealing with other water vector-born diseases, certain refugee camps may not be in place long enough for the projects to be worth while; here it is important to remember that returning the refugees to their native land is a top priority as soon as the reason for dislocation has been resolved.

I do not have any recommendation for further research, seeing that an effective preventive treatment and therapy have been found for Schistosomiasis. However, I would like to point out that I was not able to find any studies on PubMed looking at the prevalence or intervention efforts related to Schistosomiasis in refugees that remained in the Sub-Saharan region. This may mean one of several things: this work is not happening – which is unlikely, this work is not being published/documented, or this work is being done and is being published but not in mainstream ways that would make it accessible to a general medical audience. I would recommend that more studies be done in the refugee population that remained in Africa, which in fact is the overwhelming majority of Sub-Saharan Africa refugees.

### **Dracunculiasis**

Dracunculiasis / Guinea Worm is the largest tissue parasite found in humans, yet until recently was among the most ignored diseases of mankind (WHO, 2008). The number of cases had dropped significantly from 35 million in 1986 to 10,674 in 2005 thanks to eradication efforts (WHO, 2008). However, the disease continues to remain an endemic in the rural areas of nine Sub-Saharan African countries, with Sudan and Ghana representing 90% of the cases. Dracunculiasis is a worm parasite, caused by the *Dracunculus medinensis* (WHO, 2008). Symptoms include severe pain if the worm migrates to a joint, fever, nausea, vomiting, and a blister that turns into an ulcer from which the worm eventually slowly emerges, usually located on the feet (WHO, 2008). Several worms are often expelled by each victim and there is no cure once infected.

Dracunculiasis is spread thanks to the symptoms it induces in infected humans. The emergence of the worm from the victim's body is accompanied by a burning sensation, which leads the infected person to place that part of their body in water. Contact with water causes the emerging female worm to release hundreds of thousands of larvae into the water (WHO, 2008). These can survive for a limited number of days by which time they must be ingested by some type of crustacean. Within 14 days the larvae grow to a stage that they are ready to infect humans (WHO, 2008). Drinking contaminated water allows for the crustaceans to dissolve in the stomach acid, after which the larvae which they carry penetrate the intestinal wall (WHO, 2008). One hundred days after infection the male and female meet and mate, after which the male dies and the female moves down the muscle planes towards the legs of the infected person (WHO, 2008). A year after infection the female worm emerges, usually from the feet of the victim, ready to disseminate the larvae she contains upon contact with water (WHO, 2008).

No research was found identifying the risk of Dracunculiasis in refugees specifically. Refugees are at risk only if they were located to certain regions in Sub-Saharan Africa where the rates of Dracunculiasis are high. Sudan, especially the southern part of the country, continues to have a high prevalence of Dracunculiasis, accounting for 78% of the reported cases of Dracunculiasis worldwide (CDC, 1998). Sudan has hosted hundreds of thousands of Ethiopian refugees in the past (Rasbridge, 2000). However conflict in Darfur caused over one million Sudanese refugees to leave the country (BBC, 2004). With negotiation talks taking place for refugees to be returning home, it is now

crucial to work with these returning refugees to halt the spread of Dracunculiasis in rural Sudan. There are currently 40,000 Liberian Refugees in Ghana (IRIN, 2008). This population may be at increased risk for Dracunculiasis, with Ghana being the country with the second highest prevalence rate (WHO, 2008).

Dracunculiasis, though rarely deadly, is highly debilitating, with the victim not being able to walk for around a month or more. Refugees have been consistently shown to be highly traumatized by definition as a result of their relocation experience and the events that brought it about. Up to 86% of a refugee population have been shown as suffering from Post-Traumatic Stress Disorder, though the estimates depend on the refugee population (US Department of Veterans Affairs, 2008). Dracunculiasis is reported as having severe moral impact on the affected, aside from the mention the economic and physical burden associated with being bedridden during the agricultural season (WHO, 2008). This suggests that refugees are vulnerable to the effects of Dracunculiasis on several levels, including their mental health.

Since there is no current treatment for Dracunculiasis, the WHO together with private NGO's have placed the focus on eradication of Dracunculiasis. Complete eradication of the Dracunculiasis may be possible, and has been highly successful with a 99% in case rate since the beginning of the campaign in the 1980's (WHO, 2008). The program uses case-containment of the infected person within 24 hours after the emergence of the worm (WHO, 2008). The patient has his leg cleaned and bandaged, and is told to keep away from water. Infected drinking water can be treated with temephos insecticide (Abate<sup>®</sup>) to kill the Dracunculiasis larvae (WHO, 2008). Despite this measure all drinking water is also filtered through cloth filters, which are a cheap and effective way to prevent infection. Continual strong surveillance and reporting are necessary to progress with the eradication campaign.

Research is needed for how to treat a person already infected with the worm. Currently, no drug treatment exists, and recommendations revolve around keeping the wound bandaged and slowly pulling the worm from the person's body without breaking it. This process is unbearably slow, often lasting several weeks. Though eradication of Dracunculiasis should remain the goal of the campaign, additional treatment should also be considered.

## **Conclusion**

The Sub-Saharan region is home to the second largest population of refugees worldwide, only slightly surpassed by the Asia/Middle East region. It is universally recognized that refugees are a highly vulnerable population, with the United Nations granting them special rights and protections. Comprised of 80% women and children who have been displaced from their homes due to war, persecution, or disaster, refugees are in a frail physical and mental state of health. Sub-Saharan Africa, especially the rural areas, is simultaneously one of the poorest, least developed, and most disease stricken regions of the world, though there are areas within the region that do not fit this description. Lack of access to clean water for drinking and bathing puts many communities at risk. It

is suspect that refugees are at higher risk due to the burden and trauma of relocation, especially if this is done to areas that were formerly uninhabited due to disease epidemics of lack of safe drinking water. The focus of this paper was on the vector-borne diseases related to water in Sub-Saharan Africa: malaria, onchocerciasis, schistosomiasis, and dracunculiasis. Since only dracunculiasis is contracted through ingestion, I think this points out to the bigger picture of the water related problem in parts of this region. This being that it is not enough to filter the drinking water, thought this is a great public health step which is also very cost effective. Interventions must focus around disease containment, water treatment, pathogen control, and, if possible, eradication. Fortunately there is hope as the rate of each of these devastating illnesses has been decreasing with time.

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