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The impact of neglected tropical diseases on women and girl refugees: A call for increased awareness and strategic intervention

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As the number of forcibly displaced women and girls increases, it becomes ever important to recognize the negative health impacts of being displaced. Women and girl refugees are disproportionately affected by sexual and gender-based violence and mental health concerns. In addition to these health concerns in women, crowding and lack of clean water in refugee camps leads to the spread of infectious diseases in general. Neglected tropical diseases (NTDs) are infectious diseases of poverty found in tropical areas, and longstanding infections lead to significant morbidity. Particularly for women, these diseases can impact fertility, chronic disease in pregnancy, and social stigma. Despite being a high-risk group, there are minimal data on the impact of NTDs on the health of Women and girl refugees. Diseases such as schistosomiasis, soil-transmitted helminth infections, strongyloidiasis, and leishmaniasis have all been shown to affect Women and girl refugees, but the majority of these data describe NTDs in this population only after resettlement. Access to medical care with providers that are knowledgeable about NTDs while in situations of displacement as well as after third-country resettlement is crucial to their timely diagnosis and treatment to prevent longstanding sequalae. More studies in this at-risk population are needed to understand the extent of this issue and begin to work towards lasting, equitable healthcare.

KEYWORDS

refugee camp, women, parasites, schistosomiasis, soil-transmitted helminth, strongyloidiasis, displaced, resettlement

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Introduction

The number of forcibly displaced persons has been increasing over the past decade (1). The office of the United Nations High Commissioner for Refugees (UNHCR) found that 89.3 million people were displaced worldwide as a result of persecution, conflict, violence, and human rights violations as of December 2021 (2). Of this number, 27.1 million were refugees (21.3 million under UNHCR's mandate and an additional 5.8 million Palestinian refugees under the mandate of the United Nations Relief and Works Agency) (3), while 53.2 million were internally displaced people, 4.6 million were asylum seekers, and 4.4 million Venezuelans were displaced abroad (4). By May 2022, an additional 10.7 million people were displaced due to the war in Ukraine and other conflicts, propelling the total to 100 million people who have been displaced worldwide (4). Approximately six million refugees (22% of the global refugee population) live in refugee camps, temporary settlements that provide immediate protection and centralized humanitarian assistance (3, 5). There are refugee camps worldwide (Figure 1), the largest camp being found in Bangladesh, reflecting the global need to provide aid to refugees (3). While refugee camps are not established to provide permanent humanitarian solutions, most operations last longer than expected leading to displacement that can transcend generations (3).

While there are established international minimum standard guidelines for refugee camps to provide for basic needs such as food, clean water, sanitation, shelter, and medical treatment, the ability to comply with these standards can be challenging (3). The emergent need to set up camps during early crises before resources are available, in addition to the challenge of sustaining resources over time, limit the capability to consistently provide these basic needs. As a result, health concerns like mental health conditions, injuries, and other non-communicable diseases are frequent amongst refugees. Unfortunately, these conditions also disproportionately affect women and girls (6–8). For example, previous studies have shown that there is an increased prevalence of sexual and gender-based violence in women in refugee camps, especially for women with disabilities (9, 10). Women and girl-specific needs such as family planning and basic health during pregnancy require particular attention in refugee camps (11–13). Despite resource limitations, the Inter-Agency Working Group has put forth recommendations on minimum initial services for sexual and reproductive health with the ultimate goal of decreasing morbidity and mortality in crisis-affected populations. These standards build upon pre-established facilities within camps and emphasize sexual violence prevention and supportive care, addressing maternal and newborn morbidity and mortality as well as prevention of unintended pregnancies (14–16). Refugee women and girls are also disproportionately affected by mental health concerns (17). In Syrian refugees living in a refugee camp in Greece, female sex and each additional child were significant risk factors for major depressive disorder (adjusted odds ratios 3.23 and 1.61, respectively) (18). The established power structure within refugee camps, which is typically constructed by men, further exacerbates non-communicable health concerns in women and girls (19).

Beyond non-communicable health concerns in women and girls living in refugee camps, the lack of consistent potable water, sanitary disposal, and housing infrastructure – along with living in close proximity to others –increases the risk of infectious disease transmission and outbreaks in refugee camps. The most common sites of infection in refugee populations include the respiratory tract, skin and soft tissue, urinary tract, and GI tract (20, 21). When tracking epidemics specifically, the leading causes of infectious outbreaks within refugee camps were found to be measles, cholera, and meningitis, some of which can be further exacerbated by delayed or missed childhood vaccinations (22). Additionally, neglected tropical diseases (NTDs) – a collection of parasites, bacteria and viruses

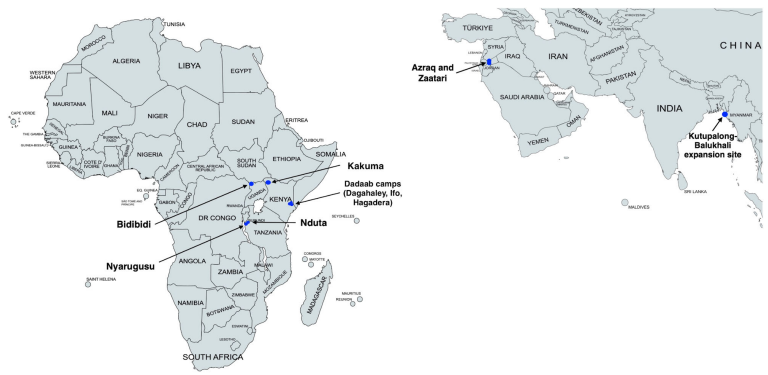

FIGURE 1
Map of 10 largest refugee camps in the world (3). Created with mapchart.net.

endemic in tropical and subtropical regions of poverty – are increased in regions of unrest and displacement, including refugee camps. Inconsistent camp conditions, transient populations, and the lack of NTD eradication programs within early stage refugee camps leads to ongoing NTD transmission within the community and even introduction of new NTDS within the community (23). Furthermore, the latency of NTD disease presentation makes diagnosis in refugee camps challenging, often leading to delayed treatment and the development of lifelong morbidity once recognized years after initial infection. Due to the known increased risk factors for infectious diseases and the roles women and girls play in refugee camps such as washing clothes, collecting water, and child care, women and girls are specifically at increased risk for infectious pathogens including NTDs. Unfortunately, there remains a paucity of data evaluating the devastating impact of NTDs on the health of women and girl refugees. In this review, we will highlight the available literature and advocate for increased awareness of NTDs in women and girls within refugee camps and upon resettlement.

Neglected tropical diseases in women and girl refugees

NTDs are common in regions of poverty and disproportionately affect women and children (24). The consequences of these infections can be lifelong, impacting growth and development, reproductive health and fertility, exacerbation of disease in pregnancy, and social exclusion and stigma (25). While NTDs are not equally distributed around the world, certain NTDs are more commonly identified in persons escaping social and political unrest due to the loss of NTD public health control efforts during times of conflict (26).

Schistosomiasis, caused by the trematodes *Schistosoma mansoni*, *S. haematobium*, and *S. japonicum*, is endemic in regions within Africa, Asia and the Middle East. It is a waterborne disease, perpetuated by exposure to contaminated fresh water used for cleaning, drinking, and bathing (27). Thus, people whose daily activities include contact with contaminated water such as doing laundry, bathing, and fishing in endemic regions, including in refugee camps, are more commonly affected (28). While the true burden of disease varies depending on the camp, several studies have found high seroprevalence of disease within refugee populations. For example, the Lost Boys and Girls of Sudan and Somali Bantu, both cohorts who spent time in the Kakuma refugee camp in northwestern Kenya and subsequently resettled in the United States, were found to have high rates of schistosomiasis. Approximately 44% of Sudanese and 73% of Somali Bantu refugees that were tested were seropositive for schistosomiasis (29). Additional studies focused on refugees from Africa who subsequently resettled in Canada and Germany were found to have seropositivity for *Schistosoma* spp. of 15% and 19%, respectively (30, 31). During the Second Sudanese Civil War in the 1990s, 26% of refugees who were displaced to shanty towns in the capital city of Juba were found to have *S. mansoni* infection. Interestingly, women refugees had higher observed seroprevalence of infection compared to males (33% and 22%). Additionally, housewives were among the occupations with the highest seroprevalence of parasite infections (32). The higher seroprevalence of schistosomiasis in women and girls leads to significant acute and long-term complications, including female genital schistosomiasis (which can be associated with pain), stress incontinence, infertility, and increased risk of spontaneous abortion or preterm delivery. Female genital schistosomiasis can also lead to community stigma, highlighting the need for sexual and reproductive health support for women and girls within refugee camps where schistosomiasis is endemic. Other complications observed in women and children as a result of schistosomiasis include severe anemia and malnutrition. Children living in the Mae La refugee camp along the Thailand-Myanmar border were noted to have evidence of schistosomiasis (5.4%) and anemia (11.7%) at the time of resettlement intake in Australia, although the direct association between schistosomiasis and anemia was not examined (33). Unfortunately, diagnosis of schistosomiasis can be challenging once resettled in non-endemic regions due to lack of healthcare familiarity with the infection and lack of available diagnostic assays (34). Without therapeutic intervention, infection can last for years, leading to lifelong morbidity. As a result, presumptive treatment of all refugees from endemic areas prior to resettlement (or at time of resettlement) is a cost-effective approach to reduce *Schistosoma*-associated morbidity in women and girls (35).

Soil-transmitted helminth (STH) infections, including roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and hookworms (*Ancylostoma duodenale* and *Necator americanus*) (36), in addition to *Strongyloides stercoralis*, are prevalent worldwide, estimated to infect 24% of the world's population. In refugees from the Mae La refugee camp who were screened upon resettlement in Australia, 3.4% were found to have STH despite the majority of refugees having received presumptive treatment as part of a pre-departure medical screening, and 20.8% were found to have *Strongyloides* (33). Infection with STH and *Strongyloides* results in reduced nutritional uptake and malabsorption, leading to iron deficiency anemia in children as well as impaired growth and development. Of unaccompanied minor refugees from sub-Saharan Africa who were resettled in Germany, 7.2% were found to have STH infection and 3% had *Strongyloides*. In comparison, 36% of unaccompanied minor refugees from Syria and Southeast Asia were infected with STH and 1% had *Strongyloides* (31). STH and *Strongyloides* also greatly affect women and girls of childbearing age as well as pregnant women. Maternal anemia, exacerbated by

STH infections such as hookworm, is known to be associated with pregnancy complications such as preterm delivery and low birth weight (37). A retrospective review of migrant and refugee women on the Thailand-Myanmar border found that 21.2% of pregnant women had a positive stool test for STH. Furthermore, women who were refugees had a 2-fold higher odds of STH infection as well as higher disease burden compared to women who were migrants. This was thought to be due to poorer sanitation and denser living conditions within the Mae La refugee camp compared to the living conditions observed for migrant women (38). Similarly, the prevalence of anemia in women who were pregnant in Pugnido refugee camp in Western Ethiopia was 36.1%, and intestinal parasitic infections were found to be an independent predictor of anemia (39). Given the grave outcomes of STH and *Strongyloides* infections in women and young girls, deworming has been recommended by the World Health Organization since 2002 for young children and pregnant women after the first trimester in areas where the prevalence of hookworm and whipworm is at least 20% or where the prevalence of anemia is at least 40% among pregnant women (40). However, it is estimated that only 10-20% of eligible pregnant women receive appropriate deworming (41, 42).

Leishmaniasis has three clinical manifestations: cutaneous leishmaniasis (CL), mucosal leishmaniasis (ML), and visceral leishmaniasis (VL) (43) and is endemic in 99 countries worldwide (44). As seen in Syrian refugees during the ongoing civil war that began in 2011, leishmaniasis cases dramatically increase during times of conflict in endemic regions. In Syria, the incidence of CL pre-conflict was 23,000 cases/year but arose abruptly to 41,000 cases/year, even in regions that previously had no or little documented active transmission (45). This was especially noted in refugee camps in conflict regions with dense sandfly populations where vector control programs had been dismantled. In addition to increased incidence in endemic regions, *Leishmania* spp can also be introduced into new regions as a result of mass migration of displaced persons (45). The protracted incubation period of leishmaniasis may result in development of disease after resettlement into non-endemic regions or regions with low transmission (46). In many regions, women are at increased risk of leishmaniasis due to societal responsibilities of caring for livestock and animals and other exposures that increase contact with the sandfly vector. Unfortunately, CL, which is common in areas of conflict and displacement, can lead to scarring and disfigurement that persists long after the infection is cleared and can have devastating societal implications for women and girls. Development of disfiguring lesions, particularly on the face, can lead to women being stigmatized within their community, reducing their ability to marry and maintain their livelihood. Fears of infection can cause members of the household to limit interaction with the infected person, in some cases separating mothers from their children (47). This can lead to further depression and anxiety in displaced women and girls living in refugee camps (48).

Other NTDs such as fascioliasis, onchocerciasis, dracunculiasis, lymphatic filariasis, African trypanosomiasis, Chagas disease, echinococcosis, rabies, taeniasis/neurocysticercosis, and trachoma have overlapping geographic niches with current operating refugee sites around the world and can all lead to lifelong morbidity. Previous studies have found approximately 16% of South Sudanese refugees ages 1-9 years old were diagnosed with trachoma (49). Furthermore, refugee women living in Uganda were more likely to be affected by trachoma compared to men. However, due to trachoma eradication efforts being focused mainly on children, disease identification and disease-specific management was varied (50). Taeniasis has also frequently been documented in refugees. In a remote study from 1986, 36% of West Papuan refugees who resettled in Papua New Guinea, a region previously eradicated of taeniasis, were positive for *Taenia* spp., although details on gender were not included in this report (51). Despite these short reports and small case series, large systematic data regarding NTDs, particularly in women and girl refugee populations, are overwhelmingly non-existent. Without more robust data on this at-risk group, public health interventions to reduce NTD-associated morbidity in women and girl refugee will remain limited.

Resettlement in third countries

Pre-resettlement evaluation

Prior to resettlement, refugees undergo a pre-travel screening process that consists of evaluation for potential medical conditions that could impact not only individual health, but community health as well (52, 53). In general, medical screening includes medical history, physical exam, review of vaccinations needed prior to departure, testing for syphilis, and a chest radiograph to assess for evidence of tuberculosis (TB) (53, 54), but specific guidelines differ by resettlement country. Although there are currently no mandatory screening processes for NTDs prior to resettlement in the US, implementation of presumptive treatment prior to resettlement (rather than screening) has led to decreased NTD disease burden in refugees arriving to their resettlement locations. For example, the United States Centers for Disease Control and Prevention (CDC) provide recommendations regarding presumptive treatment for intestinal parasites prior to departure as part of their refugee health guidance (53). In more than 26,000 refugees from regions in African and Asia, a single dose of albendazole to presumptively treat STH infection lead to a significant decrease in prevalence of disease from 20.8% to 4.7% (55), and after the introduction of presumptive

treatment in refuges from regions in the Middle Eastern entering the United States, STH infections decreased from 2.3% to 0.1% (56). Unfortunately, presumptive treatment strategies are not ubiquitously utilized during the pre-resettlement evaluation.

Access to care once resettled

The burden of NTD infection within refugee communities can remain high after resettlement due to continued inadequate access to healthcare in the resettlement community. According to the 1951 Refugee Convention, "refugees should have access to the same or similar healthcare as host populations" (57), which is part of the agreement that a hosting resettlement country makes. Unfortunately, this is not always the case, and challenges exist to provide care to a mobile population that is unfamiliar with the structure and access points of their new nation's healthcare system. For instance, in a review of Eritrean and Sudanese refugees with chronic schistosomiasis in Tel Aviv, Israel, none were seen in follow-up due to lack of health insurance (34). In many countries, the majority of public health projects are coordinated through the Ministries of Health (MOH), which prioritize funding and resources to their native population and can exclude relocated refugee communities (58). This issue becomes compounded with refugee women and young girls, a population that is already more likely to experience gender-based sexual violence and abuse (59). Even when services are available specifically for women and girls, they in general face unique barriers to health care, such as childcare and other responsibilities that may prohibit seeking care. Additionally, certain cultural norms can dictate whether a woman receives access to care for management of an NTD. Thus, lack of access to appropriate gender-based medical care can contribute to the ongoing burden of NTDs in women and girl refugees, even upon resettlement.

Provider knowledge of NTDs

Despite the US screening and presumptive guidelines for certain NTDs in resettled refugees, a provider's knowledge of NTDs is critical within resettlement communities (30). In general, providers who have not previously encountered or worked in settings where NTDs are prevalent may not always include them in the differential diagnosis, increasing the risk of delayed diagnosis (34, 60). For NTDs that can affect fertility, delay of appropriate NTD management can result in increased burden of infertility. Additionally, limited provider knowledge of a refugee's preferred language and cultural beliefs about how and by whom care could be provided can all contribute to providing suboptimal care for NTDs during the resettlement period. Numerous studies demonstrate that NTDs are an important component of refugee women's health because they can directly affect reproductive health, increase the transmission of sexually transmitted infections (STIs), and promote gender inequality (25). Investing in provider knowledge of NTDs can play an important role in decreasing the prevalence of these diseases, especially amongst refugee women and girls.

Discussion

A call for increased awareness and strategic interventions

NTDs disproportionately affect women and girls living in poverty and can have life-long effects on women's health. Despite these risks, little is known about the burden of these infections within high-risk populations like persons living in refugee camps. Because of the lack of data, there are minimal interventions in place to reduce NTDs during the pre-resettlement and post-resettlement phase for women and girl refugees. To improve the health of women and girls suffering from NTDs, we suggest the following interventions:

1. Increased surveillance of NTDs within refugee camps with a focus on women's health clinics.
2. Implementation or expansion of NTD eradication programs within refugee camps to provide routine administration of deworming medications to children and women of child-bearing age consistent with WHO guidelines.
3. Universal adoption of pre-departure guidelines for distributing region-dependent presumptive treatment for NTDs that disproportionately affect the long-term health of women and girls (Table 1).
4. Enhancement of culturally appropriate, gender-focused health care access for women and girls upon resettlement, with increased engagement of health care specialists including obstetrician-gynecologists, family practitioners, pediatricians, midwives, nurses, and other medical professionals with specialized training in women's health.
5. Improve education of healthcare providers in resettlement areas on the risk of NTDs in women and girl refugees, focusing on disease recognition, available diagnostic tools, management options, and long-term follow-up (Table 1).

Focusing on interventions that improve the health of women and girl refugees is imperative to reduce long-term health consequences within this at-risk population. However, this can only be accomplished if more data are obtained and disseminated to key stakeholders with influence over pre-

TABLE 1 NTD screening and presumptive treatment guidelines for women and girl refugees resettled into the United States.

Pre-resettlement Screening	Post-resettlement Screening
Presumptive treatment of *Schistosoma* spp. with praziquantel[1]	Asymptomatic refugees from sub-Saharan Africa who did not receive treatment pre-resettlement can receive either presumptive treatment or a "test and treat" approach which should include *Schistosoma* IgG serology with optional testing of stool and urine for eggs and testing urine for hematuria
Presumptive treatment of Soil-transmitted helminths (STH) with albendazole[2]	Asymptomatic refugees who did not receive treatment pre-resettlement for STH can receive either presumptive treatment or a "test and treat" approach which should include two or more separate stool ova and parasite tests
Presumptive treatment of *Strongyloides* with ivermectin[3]	Asymptomatic refugees who did not receive treatment for *Strongyloides* pre-resettlement can receive either presumptive treatment or a "test-and-treat" approach which should include *Strongyloides* IgG serology with optional stool ova and parasite testing[4]

[1]This applies to refugees from sub-Saharan Africa (except for Lesotho). Refugees with known neurocysticercosis, unexplained seizure disorder, or subcutaneous nodules consistent with cysticercosis should not receive presumptive treatment.
[2]This applies to all refugees. Women should not be treated while pregnant or breastfeeding. Refugees with known neurocysticercosis, unexplained seizure disorder, or subcutaneous nodules consistent with cysticercosis should not receive presumptive treatment.
[3] This applies to all refugees. However, for refugees from Loa loa-endemic areas of Africa, presumptive treatment of Strongyloides should not occur.
[4]For refugees from a Loa loa-endemic country, Strongyloides IgG should be drawn and, if positive, Loa loa testing should be done by reviewing a daytime (10 AM to 2 PM) Giemsa-stained blood smear. If the refugee with Strongyloides also has Loa loa, that should be treated prior to treating Strongyloides. Women should not be treated while pregnant or breastfeeding for the first week after birth.

departure and post-resettlement screening and presumptive treatment. These interventions will require a global commitment and significant resource investment to provide sufficient protection for women and girl refugees.

Author contributions

MD and JW conceptualized the manuscript. MD, TP, YK, TS, KB, KF, and JW wrote and edited the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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