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TROPICAL DISEASES IN CONFLICT REGIONS (I BANI, SECTION EDITOR)

Schistosomiasis in International Refugees and Migrant Populations

Ahmed Awad Adeel[1]

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Abstract
Purpose of Review Importation of schistosomiasis by migrant populations is increasingly being recognized as a global health issue in non-endemic countries, with consequences for the infected individuals and for public health. The purpose of this review is to assess the extent of the problem and the possible ways to mitigate its impacts.
Recent Findings Published studies on schistosomiasis in migrants to the main refugee-hosting countries were identified and reviewed. The use of sensitive tests for screening indicated that the prevalence of schistosomiasis among migrants to non-endemic countries was higher than previously recognized. The establishment of schistosomiasis transmission in southern Europe had also demonstrated the ease with which the disease could be spread to new areas by moving populations.
Summary The high prevalence of schistosomiasis among refugees and migrant populations is documented by several reports from Europe, North America, Australia, and New Zealand. It is also clear that there are no uniform international protocols for screening and treatment of migrants with schistosomiasis. Moreover, the existing protocols are not being consistently implemented and may not be inclusive of all vulnerable migrants. There is a need for more research on the implementation, feasibility, cost-effectiveness, and efficacy of different protocols for screening and treatment of refugees and migrant populations from high-risk areas. There is also a need for development and evaluation of newer, more accurate diagnostic screening tests for this purpose.

Keywords Schistosomiasis · Screening · Diagnosis · Refugees · Migrants

Introduction

Schistosomiasis is a helminthic infection caused by flukes of the genus *Schistosoma*. The disease occurs in two major forms—intestinal and urogenital—caused by five species of schistosomes (Table 1) [1]. Transmission of schistosomiasis requires a freshwater snail intermediate host. The worm life cycle is completed when people suffering from schistosomiasis contaminate freshwater sources with their excreta containing parasite eggs, which hatch in water and develop in the snail host to the infective cercarial form that penetrates the skin of other individuals that come in contact with infested water. In the infected individual, the larvae develop into adult worms that live in the blood vessels where the females release eggs. Some of the eggs are passed in stools and urine and complete the life cycle, but some eggs are trapped in the tissues and may persist for more than 25 years and cause progressive damage to organs and long-term chronic complications. Long-term sequelae of *Schistosoma haematobium* infection include obstructive disease of the urinary tract and squamous cell carcinoma of the bladder. Complications of intestinal schistosomiasis caused by S*chistosoma mansoni* include intestinal polyposis, liver periportal fibrosis, and esophageal varices. There are also general systemic effects like anemia, stunting, and impaired cognition.

Schistosomiasis is endemic in 78 countries in the tropics and subtropics in areas with limited access to safe water supply and poor sanitation (Fig. 1). WHO estimated that in 2015,

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✉ Ahmed Awad Adeel
aaadeel@gmail.com

[1] 109 Villa Ridge Pkwy, Lawrenceville, GA 30044, USA

Table 1 Parasite species and geographical distribution of schistosomiasis

	Species	Geographical distribution
Intestinal schistosomiasis	*Schistosoma mansoni*	Africa, Middle East, Caribbean, Brazil, Venezuela, and Suriname
	Schistosoma japonicum	China, Indonesia, Philippines
	Schistosoma mekongi	Several districts of Cambodia and the Lao People's Democratic Republic
	Schistosoma guineensis and related *S. intercalatum*	Rainforest areas of central Africa
Urogenital schistosomiasis	*Schistosoma haematobium*	Africa, Middle East, Corsica (France)

Source: [1]. Reprinted with permission from WHO

at least 218 million people in 52 countries with moderate to high transmission required preventive treatment [2]. People become exposed to infested water as a result of occupational and domestic activities. School-aged children are particularly vulnerable to infection due to swimming or fishing in contaminated water. An estimated 85% of the world cases of schistosomiasis are in Africa [2]. Distribution of the disease tends to be focal, depending on the presence of specific snail intermediate host and human activity. Schistosomiasis control is mainly based on mass treatment with praziquantel in countries with moderate to high transmission. Other measures include provision of potable water, improvement of sanitation, and snail control.

The transmission of schistosomiasis in many endemic areas is greatly influenced by population movements. In Africa, the persistence and spread of schistosomiasis are mainly influenced by absence of control activities, low access to safe water, and human migration [3]. As an example, in Congo, the significant population movements in recent conflicts have introduced the disease in new areas [3]. Another example has been described in China, in a study comparing the epidemiology and risk factors for schistosomiasis among immigrants,

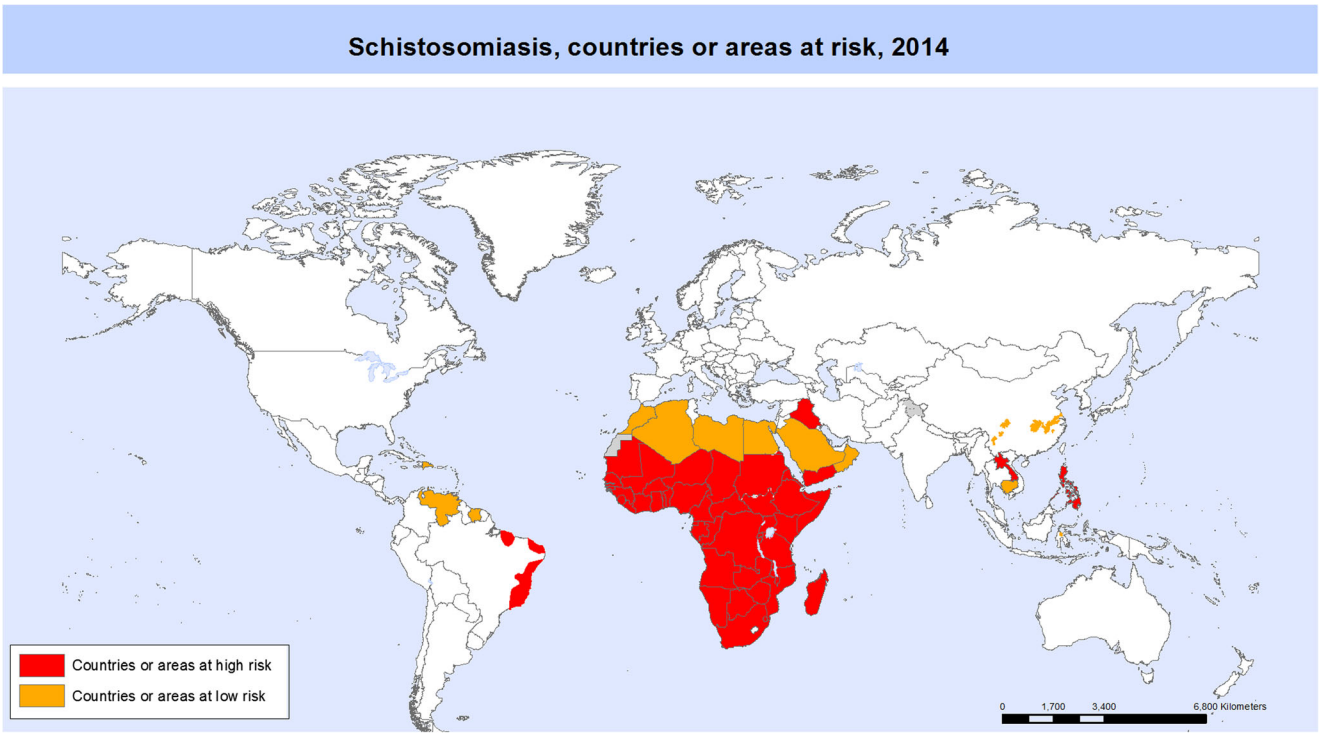

Fig. 1 Schistosomiasis, countries or areas at risk (Reprinted with permission from WHO. "Schistomiasis, Countries or Areas at Risk, 2014." Available at: http://gamapserver.who.int/mapLibrary/Files/Maps/Global_ShistoPrevalence_ITHRiskMap.png?ua=1 Accessed September 8, 2017)

emigrants, and permanent resident agricultural workers in three villages of Hunan province [4]. Although all participants had similar water contact risk, the prevalence rate of schistosomiasis in the immigrants was twice as high as in the permanent residents. There was also significant lack of awareness about the disease and its prevention among migrants compared to the permanent residents. Consequently, migrant workers took no personal protective measures. Moreover, resident workers had better access to antischistosomal chemotherapy. The discrepancy between the migrant population and permanent residents showed the impact of inadequate coverage of migrant workers by the schistosomiasis control program. In addition, it has been reported that in some cases, migrating people moved to areas where the snails were still present even after the transmission was controlled or interrupted [5]. Such issues may cause a new challenge to the control operations in the areas progressing towards the stage of transmission control or interruption, even leading to a risk of re-bouncing or re-emerging transmission.

By 2016 worldwide, an estimated 65.6 million people have been forcibly displaced from their homes because of war, violence, or oppression [6]. Nearly 22.5 million of these were refugees, and 40.3 million were internally displaced. Of the 58 million international migrants added in the north between 1990 and 2015, 44 million, or 76%, were born in the south [7]. Given these figures, the risk of importation of schistosomiasis by migrants is evident. In individuals who visited GeoSentinel clinics from March 1997 to November 2009, schistosomiasis was diagnosed in 370 of 2804 migrants from Africa (13%); although 48% were diagnosed in the first year, cases continued to be diagnosed up to 10 years after arrival [8].

The present paper reviews the published epidemiological reports on importation of schistosomiasis by migrant populations in the main countries receiving migrants from endemic areas. The main objectives are to investigate the prevalence of schistosomiasis among migrant populations and to explore the long-term impact of schistosomiasis on the migrants and on public health in the host countries.

Diagnostic and Screening Tests for Schistosomiasis

The following brief update of schistosomiasis diagnostic tests could be helpful for understanding the main epidemiological data reviewed in this paper:

Diagnosis of schistosomiasis is mainly based on parasitological tests to detect eggs in urine or fecal samples. These parasitological techniques are specific, relatively simple, and cheap. They remain as the gold standard for diagnosis of schistosomiasis in endemic areas. However, their main limitations are that the techniques are slow and labor-intensive and they are not highly sensitive. For intestinal schistosomiasis, the most widely used parasitological methods are the Kato thick smear [9, 10] and the concentration of formalin-preserved stool [11]. Parasitological diagnosis of urinary schistosomiasis is done by filtration techniques for urine samples [12].

Immunodiagnosis of schistosomiasis relies mainly on detection of specific antibodies or antigens. Antibody detection tests provide only indirect proof of exposure because they detect antibodies produced by the host's immune response to the parasite [13••]. Positive antibody tests indicate past or present exposure to infection. However, these tests are less sensitive in the identification of species other than *S. mansoni* [14]. For identification of other species, antibody detection tests are commonly combined with antigen-specific immunoblot test [15]. Another disadvantage of antibody detection tests is that they may miss prepatent and early infections, resulting in false negative tests. False positive tests could occur due to cross reactions with other parasitic infections or due to previous schistosome infection. Yet, due to their high sensitivity, antibody detection tests are recommended for screening of travelers and in populations with low prevalence of schistosomiasis [16]. Many antibody-detecting tests are being used by different laboratories, but they need to be standardized [13••].

Antigen tests therefore offer direct proof of the presence of parasites as detection of eggs. Recently developed antigen detection tests based on monoclonal antibody to detect circulating antigens have been demonstrated to have high diagnostic accuracy [17••]. These assays detect parasite-excreted circulating anodic antigen (CAA) or circulating cathodic antigen (CCA) in serum or urine samples at very low levels and have been demonstrated to have high sensitivity in field studies in China [18] and Tanzania [19]. A commercially available lateral flow-immune chromatographic reagent strip test which detects CCA in urine has been developed as a point-of-care (POC) test. This test accurately detected infections with *S. mansoni, Schistosoma japonicum*, and *Schistosoma mekongi* [17••]. A meta-analysis of 15 studies comparing the POC-CCA test and microscopy for S. *mansoni* demonstrated that POC-CCA detected a very large proportion of infections identified by microscopy, but it misclassified a large proportion of microscopy negatives as positives in endemic areas with a moderate to high prevalence of infection, possibly because the test is potentially more sensitive than microscopy [20].

A variety of molecular techniques and a range of DNA targets for detection of schistosomes have been described [21]. PCR-based technology is highly specific and sensitive and has the potential for high throughput, but DNA detection tests are hardly used for clinical diagnosis within *Schistosoma*-endemic countries because they require expensive laboratory equipment and highly skilled personnel [22].

In endemic areas, visible or microscopic hematuria is a sensitive proxy marker for urinary schistosomiasis.

Persistent eosinophilia in a person with history of exposure to schistosomiasis should also be cause for suspicion of infection. Eosinophilia has been recommended as an indication for investigations for parasitic infections in individuals newly arriving from endemic areas [23]. Clinical examination could also provide indirect clues for the diagnosis of schistosomiasis. *S. haematobium* infection is associated with symptoms and signs in the urogenital tract; *S. mansoni* and *S. japonicum* may cause diarrhea and bloody diarrhea, hepatomegaly, and splenomegaly. Late complications could be detectable by radiological imaging, particularly ultrasound examination.

Schistosomiasis and Global Migration

To explore the prevalence of schistosomiasis in migrant populations, we searched Medline to identify studies on schistosomiasis in migrants or refugees in North America, Europe, Australia, and New Zealand published between 2000 and 2017. Boolean operators (not, and, or) were also used in succession to narrow and widen the searches. Other articles were identified by reviewing the reference list of articles.

The terms "refugee" and "migrant" are frequently used interchangeably although there is a significant difference [24]. The basic difference is that a refugee is defined by the 1951 Geneva Convention [25] as a person fleeing armed conflict or persecution and thus became internationally recognized as "refugee" with access to assistance from states and international organizations. On the other hand, "migrants" choose to move not because of a direct threat of persecution or death, but mainly to improve their lives by finding work or, in some cases, for education, family reunion, or other reasons. There is also a distinction between "migrant" and "immigrant." The term "migrant" is a general designation defined by the Webster dictionary as "a person who goes from one place to another specially to find work," whereas an "immigrant" is a person who comes to a country to take up permanent residence. The present review recognizes that the use of these terms has not been uniform in the different published reports and that individuals moving from schistosomiasis-endemic countries to non-endemic countries do share similar risks and vulnerabilities and face similar conditions as the refugees. We therefore included in the review groups reported as refugees, immigrants, or migrants.

Different countries have different policies and practices regarding the screening of refugees for diseases [26•]. Thus, information about prevalence of schistosomiasis in migrant populations is found in various sources: health screening reports for refugees, clinical audits in primary care facilities, or infectious disease units that deal with migrants and refugees. In total, we have identified 38 published studies on schistosomiasis in migrant populations, including 11 studies in the USA and Canada, 13 studies in Europe, and 14 studies in Australia and New Zealand.

Schistosomiasis in Migrant Populations in North America

The USA is one of the main western countries that receive refugees. In 2015, the USA received 69,920 refugees, including 22,492 refugees from Africa [27]. Most of these come from sub-Saharan Africa, where schistosomiasis is highly prevalent. The Center for Disease Control (CDC) publishes guidelines for medical screening and treatment of USA-bound refugees including guidelines for domestic screening for intestinal parasites [28]. CDC recommends the use of serological tests as the most sensitive tools for screening for schistosomiasis besides stool and urine tests. Stool testing for schistosomiasis is recommended to be done on three specimens on three separate days. In 2005, CDC issued recommendations for predeparture treatment of schistosomiasis with praziquantel in refugees from sub-Saharan Africa who do not have contraindications [29]. An updated table of countries that are currently implementing predeparture presumptive treatment can be found at the CDC website [30••].

Table 2 shows the published reports of screening for schistosomiasis in the USA [31–40] and Canada [42]. The reported prevalence of schistosomiasis in refugees varied widely depending on many factors, including the county of origin of the refugees and the laboratory tests used for screening. The highest prevalence rates were reported from sub-Saharan Africa, with rates reaching 73% in refugees from Somalia [35] and 64% in a cohort from Sudan [36]. Screening based on stool examination showed very low sensitivity compared to serology. In the epidemiological data reviewed by Chang et al [39], serology identified 18 refugees as *Schistosoma*-positive (7.6%) but none of these was identified by stool microscopy. The results are also affected by the exact technique used in testing. In the data reported by Geltman et al [31], stool screening was based on examination of a single stool sample instead of the CDC-recommended three samples, resulting in prevalence rate of 1% in African refugees. However, methodology recommended by CDC [43] was used by most screening studies in the USA [35–39]. This approach uses a combination of tests with purified adult worm antigens for antibody detection. Serum specimens are tested by the Falcon assay screening test enzyme-linked immunosorbent assay (FAST-ELISA) using *S. mansoni* adult microsomal antigen (MAMA). A positive reaction indicates infection with *Schistosoma* species. Sensitivity for *S. mansoni* infection is 99%, 95% for *S. haematobium* infection, and < 50% for *S. japonicum* infection. Specificity of this assay for detecting schistosome infection is 99%. Because the test sensitivity with the FAST-ELISA is low for species other than *S. mansoni*, immunoblots of the species appropriate to the patient's travel history are also tested to ensure detection of *S. haematobium*

Table 2 Reports on the prevalence of schistosomiasis in migrant populations in the USA and Canada

Location	Date	Origin of immigrants	Study population	Study design	Microscopy prevalence of *S. mansoni*	Microscopy prevalence of *S. haematobium*	Schistosome serology	Reference
USA, Massachusetts	1995–2001	African	Refugee screening	Retrospective analysis of data	Single sample, 1% (8/1254)	ND	ND	Geltman et al. [31]
USA, Minnesota	1999	Africa, Asia, east Europe	Refugee screening	Retrospective analysis of data	Triplicate sample, 3% (74/2545)	ND	ND	Lifson et al. [32]
USA, Minnesota	2000–2007	Africa	Refugee routine screening + HIV surveillance	Retrospective analysis of data	3.1% (5/161) among HIV +ve 1.4% (175/12287) among HIV –ve	ND	ND	Lowther et al. [33]
San Jose, California	2001–2004	Africa and others	Refugee screening	Retrospective analysis of data	Triplicate samples. Africa 1.4% (2/142)	ND	ND	Garg et al. [34]
USA, Atlanta, GA	2004	Sudan, Somalia	Re-settled refugees	Cross-sectional survey	ND	ND	Sudanese 44% (203/462), Somali 73% (73/100)	Posey et al. [35]
USA, Atlanta, GA	2005–2006	Sudan	Re-settled refugees	Cross-sectional survey	ND	ND	64% (27/42)	Franco-Paredes [36]
USA, Atlanta, GA	2005–2008	Sudan	Re-settled refugees	Cross-sectional survey	3.5% (2/56)	0% (0/56)	44.8% (39/87)	Quandelacy [37]
USA, San Diego, California	2006–2007	Sudan	Re-settled refugees	Cross-sectional survey	ND	ND	46/171 (26.9%)	Brodine et al. [38]
USA, San Jose, California	2008–2010	Africa, Asia	Refugee screening	Retrospective analysis of data	0.8% (1/120)	ND	Africa 17%(5/29), south Asia 11% (3/27), Southeast Asia 13% (5/40), Middle East 4% (5/136)	Chang et al. [39]
USA, Somerville, Massachusetts	2012	Brazil	Immigrants within 6 months of admission	Cross-sectional survey	ND	ND	27.7 (52/188)	Rapoport et al. [40]
Toronto, Ontario, Canada	2011–2014	Africa and others	New refugee screening	Retrospective analysis of data	2/1063	ND	Africa 15%(42/278)	Redditt et al. [41]

and *S. japonicum* infections. Immunoblots with adult worm microsomal antigens are species-specific, so a positive reaction indicates the infecting species [15].

There is evidence that the CDC policy of presumptive treatment with albendazole has markedly reduced the prevalence of intestinal helminths in refugees from Middle East and south Asia [39]. However, the institution of the CDC recommendations on schistosomiasis has been variable due to funding restrictions and logistical challenges [38]. As an example, the domestic screening and presumptive treatment guidelines were not fully instituted in Illinois in 2015 due to funding restrictions and screening results for intestinal parasite in 2015 were based on stool ova and parasite examinations [44]. Review of reports from the USA shows a need for additional data on the prevalence, screening methods, and presumptive treatment of schistosomiasis among refugees.

During the period 2010−2014, Canada admitted about 49,516 refugees, excluding Quebec [45•]. Newly arrived refugees undergo health assessment and screening for diseases. For schistosomiasis, the official policy is to screen newly arriving refugees from Africa with serology and treat if positive with praziquantel [41]. Based on serological screening in 2011–2014, a prevalence of 15% was reported in African refugees in Toronto, Canada [42].

Schistosomiasis in the International Migrant Population in Europe

Europe hosts 6% of the world's displaced people [6]. One significant route of migration to Europe is the recent influx of African immigrants though the Mediterranean which has contributed to the expanding threat of importation of schistosomiasis from the highly endemic countries in sub-Saharan Africa into Europe. Of 13 published studies on schistosomiasis in refugees and migrants in Europe, six studies were from Spain [46–51], three were from Germany [52••, 53, 54], two were from France [55•, 56, 57], and one of each was from Switzerland [58] and Italy [59•].

There are no unified guidelines for screening and treatment of migrants in Europe for schistosomiasis [60]. Table 3 shows details of the screening studies for schistosomiasis done in Europe. Most of the published screening reports were not systematic screening studies but retrospective analyses of data on screening tests done in refugee or migrant patients seen in primary care clinics or referred to infectious disease hospitals. Each country and each health facilities has its own policy for the management of immigrants with schistosomiasis.

The prevalence of schistosomiasis among the refugees in Europe varied widely according to method of testing and the geographical origin of the refugees. Screening was done by serological methods in eleven studies. Four of these did not specify the type of serologic test used [50••, 52••, 53, 56], four used ELISA only [47–49, 51], one used IHA only [46], and two used a combination of serologic tests [58, 59•]. These two studies used combinations of serologic tests and also used antigen detection tests to evaluate the accuracy of using multiple tests for screening refugees. One study in Germany that did not use serology used PCR to detect schistosomal antigens in stools for screening, besides microscopy [54]. Ten studies reported using stool microscopy and urine examinations. Microscopy was mainly used to confirm results of serologic tests, but results based on microscopy alone gave very low positive rates. Stool examination was not always done according to standard techniques for schistosomiasis; only two studies confirmed using three samples for stool examination. When regions of origin of refugees were compared, the prevalence rates were the highest in sub-Saharan African refugees, ranging between 2.4% [47] and 22% [51]. For individual countries of origin, refugees from Eritrea had the highest prevalence rate reaching 56% by stool microscopy with PCR testing in Germany [54] and 50.5% by serology in Switzerland [58].

An increasing number of cases of schistosomiasis with complications have been reported among African immigrants in Europe [60, 61]. These cases were typically misdiagnosed and presented later with disease complications because they were initially seen by clinicians who were not aware of the clinical picture of schistosomiasis and lack of standard guidelines for screening of immigrants from endemic areas. In France, a study reported that in a clinic caring for vulnerable populations in Paris, no screening was done for intestinal or urinary parasitic infections in three out of five migrants from endemic areas, with a possible risk of future disease complications for missed infections [55•]. The need to educate primary care workers and physicians in Europe about schistosomiasis has been advocated [60]. Some of the published papers indicate that schistosomiasis in refugees was not considered as a public health concern as the diseases that are directly infectious. One study reporting infectious diseases in refugees in Spain did not include schistosomiasis and stated that "Eight diseases with a potential risk of transmission in our environment were studied" [62].

The potentially serious consequences of imported schistosomiasis in Europe have been realized after recent reports showing evidence of transmission of schistosomiasis in Corsica [63, 64••, 65]. These reports also stressed the potential of an even wider spread of disease transmission in Europe because *Bulinus truncatus*, the snail intermediate host for *S. hematobium*, is endemic in southern Europe, including Spain, Italy, France, and Greece. Climatic change, the establishment of an intermediate host, and the presence of non-treated schistosomiasis patients are the main factors posing a threat of establishing schistosomiasis transmission in Europe [63].

Table 3 Reports on the prevalence of schistosomiasis in migrant populations in Europe

Location	Date	Origin of refugees	Study population	Study design	Results of microscopy prevalence of *S. mansoni*	Microscopy prevalence of *S. haematobium*	Schistosome serology	Reference
Spain	1989–1999	Africa, Asia, LA	Immigrant patients	Retrospective analysis	Total 1%(9/988)	ND	ND (IHA, results not reported)	Lopez et al. [46]
Spain	1989–2008	SSA, LA	Immigrant patients + asymptomatic	Retrospective analysis	ND	ND	ELISA: patients • SSA 2.4% (38 /1564) • LA 0.2% (1/634) • Total 1.8% (39/2198) Asymptomatic 1.3% (5/396)	Monge-Maillo et al. [47]
Spain	2000–2009	SSA,LA	Immigrant patients	Retrospective analysis	ND	ND	ELISA SSA 5.8% (8 /139)	Monge-Maillo et al. [48]
Spain	2007–2010	SSA, LA	Immigrant patients	Retrospective analysis	Triplicate samples 2.7% (1/37) for serology +ve	0/37 for serology +ve	ELISA SSA 13.8% (36/260), LA 11.1% (1/9), total 13.7% (37/270)	Bocanegra et al. [49]
Spain	2009–2012	SSA	Immigrant patients + asymptomatic	Retrospective analysis	5.9% (10/171)	3.5% (6/171)	Exact test not mentioned (6.7%) 3/45 (for microscopy −ve cases)	Delcor et al. [50••]
Spain	2010–2011	SSA, LA	Immigrants with HIV and AIDS	Cross-sectional study	Duplicate samples; no eggs detected in all serology +ve	No eggs detected in all serology +ve	ELISA SSA 22% (9/41), LA 11.8% (2/17), total 18.9% (11/58)	Salvador et al. [51]
Germany	1999–2014	Africa, Asia, LA	Immigrant patients	Retrospective analysis	ND	ND	Exact serologic test not mentioned; Africa 4.28% (28/654), Asia 3.3% (7/211)	Herbinger et al. [52••]
Germany	2013–2015	Syria	New refugee screening	Retrospective analysis	No eggs detected in all serology +ve cases	No eggs detected in all serology +ve	Exact serologic test not mentioned 1.4% (7/488)	Mockenhaupt [53]
Germany	2014–2015	Africa, Asia, LA	New refugee screening	Retrospective analysis	Total 7.5% (13/173)[a] • Eritrea 56% (9/16) • Somalia 5% (1/21) • Other African 20% (2/10) • Afghanistan 1.2% (1/81)	ND	ND	Maaßen1 [54]
Switzerland	2016	Eritrea	New refugees	Cross-sectional study	Duplicate samples 21.5% (23/107)	ND	ELISA + IFAT 50.5% (54/107)[c]	Chernet et al. [58]
France	2003	Africa, Asia, ME, LA	Immigrant patients	Retrospective analysis	20% (32/161)	13% (22/171)	ND	Deniaud et al. [55•]
France	2011–2013	Africa	Immigrant patients	Retrospective analysis	4.8% (5/105)	1.9% (2/105)	Exact serologic test not mentioned 10% (10/105)	Monpierre et al. [56, 57]
Italy	2014–2016.	Africa	New refugees	Cross-sectional study	Triplicate samples 8.6% (32/373)[b]	10.7%(40/373)[b]	ELISA + Western blot +ICT[d]. Composite reference standard (CRS) = 38.6% (144/373)	Beltrame et al. [59•]

SSA sub-Saharan Africa, *LA* Latin America, *ND* not done or not reported

[a] Stools tested by microscopy and PCR

[b] Total prevalence by microscopy is 17.4% (65/373); seven patients had positive microscopy for *S. mansoni* and *S. hematobium*

[c] Urine test (POC-CCA) for *S. masoni* was also done; 59% of subjects (63/107) were +ve with at least one of the three tests done: microscopy, serology, or POC-CCA

[d] Panel of serological tests and urine circulating cathodic antigen (CCA) dipstick test were used. Modeling result of microscopy together with serology and the CCA proportion of positive results according to the composite reference standard (CRS) was 38.6% (144/373). According to LCA modeling, the proportion of subjects classified in class 1 was 35.6%

Table 4 Reports on the prevalence of schistosomiasis in migrant populations in Australia and New Zealand

Location	Date	Origin	Study population		Microscopy prevalence of *S. mansoni*	Microscopy prevalence of *S. haematobium*	Schistosome serology	Reference
Melbourne, Australia	2000	East Africa	Refugees and immigrants	Cross-sectional study	ND	ND	15% (19/124)	Caruana et al. [69]
Melbourne, Australia	2000–2002	East Africa	Clinic patients	Cross-sectional study	1% (1/133)	ND	2% (3/133)	Rice et al. [70]
Western Australia, Australia	2003–2004	Africa + other countries	New refugee screening	Retrospective analysis	SSA 7%, n = 1245; North Africa 3%, n = 420; others: 4%, n = 26	ND	ND	Martin and Mak [71]
NSW, Australia	2005	Africa, Middle East, Asia	Clinic patients	Retrospective analysis	ND	ND	27% n = 331	Raman et al. [72]
Newcastle, NSW, Australia	2005	Africa	New refugee screening	Cross-sectional study	ND	ND	34% (76/222)	Davis et al. [73]
Melbourne, Australia	2005	Africa	Refugee patients	Cross-sectional study	ND	ND	12.4% (27/217)	Tiong et al. [74]
Melbourne, Australia	2003–2006	Africa	Immigrant patients	Retrospective analysis	4/145 (2.8%)	−ve	84/206 (40.8%)	Gibney et al. [75]
Sydney, NSW, Australia	2005–2006	Africa	Pediatric refugee clinic	Cross-sectional study	ND	ND	West Africa 37% (15/42); Central Africa 39% (17/44); East Africa 6% (5/82)	Sheikh et al. [76]
Western Australia, Australia	2006–2008	Africa, Asia, east Europe	Pediatric refugee clinic	Retrospective analysis	ND	ND	16.6% (170/1026)	Mutch et al. [77]
Darwin, Australia	2009–2010	Africa, Asia	New refugee screening	Retrospective analysis	−ve	−ve	Africa 14% (11/76), Asia: 18% (20/110), total: 17% (31/186)	Johnston et al. [78]
Melbourne, Australia	2004–2008	Myanmar	Refugee patients	Retrospective analysis	ND	ND	5.4% (8/147)	Chavez et al. [79]
Melbourne, Australia	2006–2009	Myanmar	New refugee screening	Retrospective analysis	ND	ND	7% (80/1136)	Paxton et al. [80]
New Zealand	1995–2000	Africa, Middle East, Asia, others	Refugee screening	Retrospective analysis	2.8% (80/2992)	ND	21.9% (620/2825)	Mc Leaod [81]
New Zealand	2007–2011	Africa, Asia, Middle East	Refugee screening	Retrospective analysis	ND	ND	4% (13/343)	Rungan et al. [82]

Schistosomiasis in the Immigrant Population in Australia and New Zealand

The 2015–2016 humanitarian program of Australia granted 15,552 offshore refugee and humanitarian visas, of which 58.9% were granted to persons born in Middle East,

29.3% to persons born in Asia, and 11.8% to persons born in Africa [66].

Many centers in Australia currently screen and treat people from refugee-like backgrounds for schistosomiasis. In general, the health authorities in the different centers follow the policy recommended by the Australasian Society for Infectious Diseases (ASID) which is as follows [67, 68•]:

Offer blood testing for schistosomiasis serology if people have lived in/travelled through endemic countries.

- If serology is negative, no follow-up is required.
- If serology is positive or equivocal

  – Treat with praziquantel in two doses of 20/mg/kg, 4 hours apart, orally. (40 mg/kg total, no upper limit)
  – Perform stool microscopy for ova.
  – Perform urine dipstick for hematuria and end-urine microscopy for ova if hematuria.

- If positive for ova on urine or stool, evaluate further for end-organ disease with ultrasound and LFTs. See flowchart for further details.
- Seek advice from a pediatric specialist on treatment of children < 5 years.

Table 4 shows details of screening studies in Australia [69–80] and New Zealand [81, 82].

Most reports of screening data on schistosomiasis are about refugees from Africa. Positive schistosomiasis serology in African refugees ranged between 2% [70] and 40.8% [75]. Asian refugees from Myanmar tested positive in 5.4% [79] and 7% [80] Most of the reports were based on patients seen in refugee clinics, but this may not cover all the refugees with schistosomiasis. Raman et al [72] reported that while New South Wales state of Australia received 1,557 refugee children (< 14 years) in 2005, only about one in five (n = 331) was seen in a refugee-specific clinic. Of those assessed, 27% were serology-positive for schistosomiasis.

New Zealand accepts 750 "quota" refugees annually. On arrival in New Zealand, refugees are received into the Mangere Refugee Resettlement Centre (MRRC) where they undergo medical screening for communicable disease control [83]. Retrospective studies on screening of refugees in New Zealand reported prevalence of rates of 21.9% [81] and 4% [82] in groups of refugees from different origins.

Conclusions

The need for better detection and treatment of schistosomiasis in migrant population is increasingly being recognized as a global health issue that needs to be addressed. After using sensitive serologic tests for screening, it was realized that prevalence of this infection was greater than had been previously detected by conventional parasitological tests. The increase in global migration from endemic areas has increased the risk of exporting cases of the disease to non-endemic areas. Early screening and treatment of schistosomiasis could forestall development of serious disease complications downstream. At the public health level, the recent evidence of the transmission of schistosomiasis in southern Europe showed how easily the disease could be introduced into new territories. This calls for reviewing the screening and treatment policies in countries where the disease is not endemic. There are also implications for the global strategies for schistosomiasis elimination. The published reports on screening for schistosomiasis show a need for further evaluation of the feasibility and cost-effectiveness of the different options for screening refugees and migrants, including domestic and predeparture screening and treatment protocols. The value of laboratory tests needs to be reviewed in different settings. Such a review should consider targeted testing, the diagnostic accuracy of serology, stool antigen testing, and combinations of laboratory tests. Screening for schistosomiasis should not be limited to those officially defined as refugees but should also include other vulnerable migrants who could benefit from the refugee screening strategies.

Compliance with Ethical Standards

Conflict of Interest Ahmed A. Adeel declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by the author.

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