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Decreasing Intestinal Parasites in Recent Northern California Refugees

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Abstract. Beginning in 2005, the Centers for Disease Control and Prevention (CDC) expanded the overseas presumptive treatment of intestinal parasites with albendazole to include refugees from the Middle East. We surveyed the prevalence of helminths and protozoa in recent Middle Eastern refugees (2008–2010) in comparison with refugees from other geographical regions and from a previous survey (2001–2004) in Santa Clara County, California. Based on stool microscopy, helminth infections decreased, particularly in Middle Eastern refugees (0.1% versus 2.3% 2001–2004, $P = 0.01$). Among all refugees, *Giardia intestinalis* was the most common protozoan found. Protozoa infections also decreased somewhat in Middle Eastern refugees (7.2%, 2008–2010 versus 12.9%, 2001–2004, $P = 0.08$). Serology for *Strongyloides stercoralis* and *Schistosoma* spp. identified more infected individuals than stool exams. Helminth infections are increasingly rare in refugees to Northern California. Routine screening stool microscopy may be unnecessary in all refugees.

INTRODUCTION

Over the past decade, 30,000–80,000 refugees have entered the United States each year.[1] California, the leading state of residence for these individuals, accepted between 8% and 24% of all refugees.[2] This large population has unique health care needs. Among these, a high prevalence of intestinal parasites has been reported in various groups of refugees.[3–6] Untreated intestinal parasites can have serious long-term health consequences. For example, anemia, growth retardation, and cognitive impairment can develop in children with chronic hookworm infection,[7,8] and in adults, significant morbidity and mortality has been caused by hyperinfection with *Strongyloides stercoralis*.[7–10] In 1999, after presumptive parasite treatment in immigrants was determined to be cost-effective, the Centers for Disease Control and Prevention (CDC) recommended single-dose albendazole to refugees > 2 years of age from sub-Saharan Africa and Southeast Asia.[11,12]

Since 2005, the number of refugees from the Middle East has increased 10-fold. Previously a mere 3–4% of all refugees, by 2008, Middle Eastern refugees comprised nearly one-third of all refugees entering the United States.[1] During this period, the CDC also expanded presumptive pre-departure albendazole treatment to the Middle East, South Asia, and instead of only sub-Saharan Africa, the entire African continent. The epidemiology of intestinal parasites in refugees from the Middle East has not been well described. Furthermore, the extent to which albendazole has been used overseas is uncertain, as is the impact of the broader pre-departure treatment recommendations on the prevalence of intestinal parasites in recent Middle Eastern refugees. The objective of this study was to characterize the parasite infection profiles of Middle Eastern refugees in comparison with profiles of refugees from other geographical regions who arrived in Santa Clara County, California from 2008 to 2010. In addition, to estimate the extent to which albendazole has been effective for intestinal parasites, we compared the prevalence of helminths and protozoa in current refugees to that of refugees in 2001–2004.

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METHODS

Population. The California Department of Public Health's Refugee Health Assessment Program (RHAP) serves as an initial health system contact for refugees who are referred within 90 days of arrival in the United States. Through the RHAP, incoming refugees receive a thorough health evaluation that includes screening for intestinal parasites. Santa Clara County is one of 10 counties in California to provide such screening evaluations, which take place at the Santa Clara County Tuberculosis Clinic and Refugee Health Assessment Program in San Jose, CA.[13] Subjects consisted of all persons who were referred to the RHAP from June 1, 2008 until November 30, 2010. Informed consent was obtained from a convenience subset sample of 238 refugees who were examined in more detail. These individuals were healthy, 18–55 years of age, had been living in the United States for < 2 years, and spoke English, Arabic, Burmese, Chinese, Farsi, Spanish, or Vietnamese (languages for which we had translators).

To determine changes in immigration trends and parasite infections, we compared current refugees (2008–2010) with a historical cohort of previously described refugees from the Santa Clara county RHAP who were similarly evaluated from October 1, 2001 to January 30, 2004.[14] The study was approved by the institutional review boards at Stanford University and Santa Clara Valley Medical Center.

Data collection. Stool collection for ova and parasite (O&P) evaluation was carried out with the ParaPak ULTRA Stool Transport and Filtration System, which contained two 15-mL vials. One vial contained zinc sulfate and polyvinyl alcohol to preserve trophozoites and cysts, whereas the other contained 10% formalin for direct examination (Meridian Bioscience, Cincinnati, OH). Stool specimens were processed by the Santa Clara County Microbiology Laboratory, Parasite Division (San Jose, CA). *Strongyloides* and *Schistosoma* spp. serology assays done for the subset of 238 individuals who gave informed consent) were conducted using commercial enzyme-linked immunosorbent assay kits according to manufacturer's instructions (Scimedx, Denville, NJ).

De-identified data for all refugees were obtained from the RHAP and included demographic characteristics, immigration status, country of birth, number of stool specimens submitted for examination, stool ova and parasite results, and species identification.

Analyses. We compared the characteristics of refugees who completed the health assessment with those who did not complete evaluations offered through the RHAP. Country of birth was classified according to the United Nations categories of geographical regions as follows: Africa, East Asia (China, Korea, Mongolia), Middle East (Armenia, Azerbaijan, Georgia, Iran, Iraq, Jordan, Kuwait, Lebanon, Saudi Arabia, Syria, Turkey), South Asia (Afghanistan, Bhutan, India, Nepal, Kazakhstan, Pakistan), and Southeast Asia (Thailand, Vietnam, Burma, Cambodia, Indonesia, Malaysia, Philippines). Because of the low numbers of refugees, the following regions were grouped as "Other": Eastern Europe (N = 10), South and Central America (N = 7), and South Europe (N = 1). Education information was available only for those who initiated the health assessment.

In the analyses of stool results, only individuals who turned in at least two stool specimens were included. Non-pathogenic parasites were excluded. We assessed the prevalence of protozoa and helminth infections by species count. As a result of the presence of multiple infections in samples from some subjects, species counts were greater than person counts. Regions with fewer than five infected individuals were excluded from analysis (East Asia and Other).

Differences between groups were assessed using the χ^2, Fisher's exact test, or Wilcoxon rank-sum test as appropriate. Multivariate logistic regression was performed to estimate adjusted odds ratios and associated 95% confidence intervals for protozoa and helminth infections in separate models. In the comparisons of the 2001–2004 and the 2008–2010 cohorts, Southeast Asia was excluded as a result of low numbers of refugees from this region in the older cohort.

Analyses were carried out using SAS, version 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

One thousand three hundred and seventy-six (1,376) refugees were referred to the RHAP from June 1, 2008 to November 30, 2010 (Figure 1). The great majority of them (N = 1238, 90%) completed the refugee health assessment. Of these, 1,232 (89.5%) turned in at least two stool specimens for ova and parasite testing and were included in our analysis. Of the 138 (10%) who did not complete the health evaluation, 74 (54%) did not start the program because: they could not be located (N = 34, 46%), moved out of the county (N = 34, 46%), chose another health care provider (N = 4, 5%), declined (N = 1, 1%), or died (N = 1, 1%). The 64 refugees (46%) who began but did not complete the health assessment consisted of 48 (75%) who moved out of the county, 13 (20%) who changed health care providers, and 3 (5%) who were lost to follow-up.

Characteristics of refugees completing the RHAP. There were similar numbers of men and women refugees. The median age of all refugees was 29 years, and age ranged from 0 to 87 years. Children (< 18 years of age) were less likely to complete the evaluation than adults (P = 0.03). During 2008–2010, the region with the highest number of refugees referred to the RHAP was the Middle East (N = 777, 56%). A high proportion of Middle Eastern refugees, 93.7%, completed the RHAP. In contrast, East Asian refugees showed low participation, with only 48% of eligible refugees completing the health assessment. Among Africans, Congolese were the largest group (25.7%), followed by Ethiopians (19.4%), Eritreans (18.8%), and Somalis (15.3%). Among South Asians, refugees from Bhutan and Nepal made up 83.2% of the group. In Southeast Asia, Vietnam and Burma were the two most represented countries (92.7% cumulative). East Asia was almost entirely

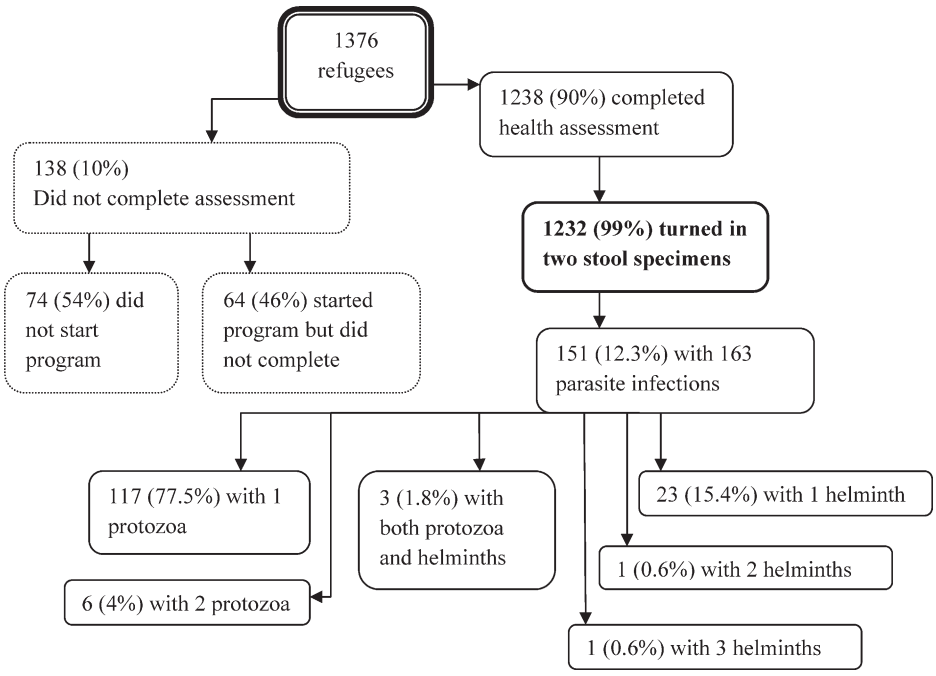

FIGURE 1. Flow chart of 1,376 refugees referred to the Santa Clara Valley Refugee Health Assessment Program from June 1, 2008 until November 30, 2010. The 1,232 refugees turned in at least 2 stool specimens and were included in the analyses. There were 151 persons harboring 163 protozoa and/or helminth infections.

TABLE 1

Characteristics of 777 Middle Eastern refugees and 599 refugees from other regions referred to the Santa Clara Valley Refugee Health Assessment Program (RHAP) from June 1, 2008 to November 30, 2010

	Middle East $N = 777$		Other regions $N = 599$		Total $N = 1,376$
Sex					
Female	387	49.8%	275	45.9%	662
Male	390	50.2%	324	54.1%	714
Age					
Median, Q1–Q3	31	22–47	25	17–40	
0–10	76	9.8%	66	11.0%	142
11–17	58	7.5%	62	10.4%	120
18–34	315	40.5%	264	44.0%	579
≥ 35	328	42.2%	207	34.6%	535
Education*					
No formal education	80	10.6%	110	20.1%	190
1–11 years	234	31.0%	285	52.2%	519
≥ 12 years	442	58.4%	151	27.7%	593

*Data missing for 74 refugees who did not begin the RHAP.

composed of refugees from China (80%). There were very few refugees from Europe and Latin America

Characteristics of Middle Eastern refugees. Compared with refugees from other geographical regions, Middle Eastern refugees were somewhat older and had received more education (Table 1). The majority of Middle Eastern refugees had completed at least high-school level education (58.4% versus 27.7% in refugees from other regions, $P = 0.001$). Iranians and Iraqis comprised 96.4% of the refugees from the Middle East and 54.4% of all refugees. The great majority of Iranian refugees ($N = 350$, 87.5%) arrived in the United States through Austria, where almost all ($N = 336$, 96%) had lived for no more than 6 months before emigration. The second most common country of residence of Iranian refugees before emigration was Turkey ($N = 41$, 10.3%). For Iraqi refugees, the four most common countries of residence before emigration were Syria ($N = 108$, 31%), Jordan ($N = 103$, 29.5%), Iraq ($N = 52$, 14.9%), and Turkey ($N = 47$, 13.5%).

Prevalence of intestinal parasites 2008–2010. There were 368 stools that were positive for pathogens, representing 163 infections in 151 (12.3%) people (Table 2). Eleven refugees (7.3% of infected, 0.9% of all tested) had multiple parasites. Among the 140 infected with a single parasite, all three stools were positive in 61.1% and at least two stools were positive in 80.9%.

In total, 126 refugees (10.2%) had intestinal protozoa in their stool. *Giardia intestinalis* (syn. *Giardia lamblia* and *Giardia duodenalis*) was the most common protozoan identified (4.1% of all tested, and 41.1% of persons with protozoan infections), followed by *Dientamoeba fragilis* (3.4% of all tested, and 38.6% of protozoan infections) (Table 2, last column). In contrast to protozoa, helminth infections were rare overall. Only 28 refugees (2.3%) had positive stools for helminths, with hookworm being the most common (1.1% of all tested, 41.9% of helminth infections).

TABLE 3

Multivariate logistic regression of risk factors for helminth and protozoa infections in 1,232 refugees. Adjusted odds ratios and 95% confidence intervals*

	Protozoa		Helminth	
Risk factor	AOR (95% CI)	*P* value	AOR (95% CI)	*P* value
Age				
Per 10-year increase	0.9 (0.8–1.0)	0.04	1.1 (0.9–1.3)	0.56
Sex				
Male	1.3 (0.9–2.0)	0.15	3.3 (1.3–8.5)	0.01
Female	Reference		Reference	
Region				
Africa	2.4 (1.3–4.5)	0.005	29.9 (3.3–269)	0.002
South Asia	3.6 (2.1–6.1)	< 0.001	10.8 (1.1–108)	0.04
Southeast Asia	1.1 (0.6–1.9)	0.77	31.3 (4.1–240)	< 0.001
Middle East	Reference		Reference	
Education				
< 12 years	0.9 (0.6–1.4)	0.70	3.9 (1.1–13.6)	0.04
≥ 12 years	Reference		Reference	
Year of arrival				
2008	2.3 (1.3–3.9)	0.002	5.3 (1.6–18.3)	0.008
2009	1.1 (0.7–1.9)	0.69	2.7 (0.8–9.5)	0.12
2010	Reference		Reference	

*AOR = adjusted odds ratio; CI = confidence interval.

TABLE 2

Geographical distribution of intestinal parasites identified through stool ova and parasite tests. Regions with fewer than five infected individuals were excluded

	Africa $N = 120$	Middle East $N = 721$	South Asia $N = 111$	Southeast Asia $N = 254$	Total $N = 1,232$*
Protozoan infections†					
Blastocystis hominis	18 (15.0%)	52 (7.2%)	33 (29.7%)	25 (9.3%)	132‡ (10.7%)
Dientamoeba fragilis	0	4 (0.6%)	4 (3.6%)	6 (2.4%)	14 (1.1%)
Entamoeba	1 (0.8%)	23 (3.2%)	10 (9.0%)	5 (2.0%)	41 (3.3%)
histolytica/dispar	5 (4.2%)	15 (2.1%)	5 (4.5%)	1 (0.4%)	26 (2.1%)
Giardia intestinalis	12 (10.0%)	10 (1.4%)	14 (12.6%)	13 (5.1%)	51 (4.1%)
Helminth infections†	5 (4.2%)	1 (0.1%)	3 (2.7%)	21 (8.3%)	31‡ (2.5%)
Ascaris lumbricoides	0	0	0	0	0
Clonorchis sinensis	0	0	0	1 (0.4%)	1 (0.1%)
Hookworm	0	0	0	13 (5.1%)	13 (1.1%)
Hymenolepsis nana	1 (0.8%)	1 (0.1%)	3 (2.7%)	0	5 (0.4%)
Schistosoma spp.	1 (0.8%)	0	0	0	1 (0.1%)
Strongyloides stercoralis	3 (2.5%)	0	0	5 (2.0%)	8 (0.6%)
Trichuris trichuria	0	0	0	2 (0.8%)	3 (0.2%)
TOTAL persons infected	23 (19.2%)	53 (7.4%)	31 (27.9%)	39 (15.4%)	151† (12.3%)

*The 26 refugees from East Asia, Eastern Europe, South & Central America, and South Europe are not represented separately because of small numbers.
†Species counts exceed person counts because of mixed infections in 11 individuals.
‡Out of the geographical regions not represented separately because of small numbers of refugees, there were five infections with intestinal parasites: four protozoa and one helminth.

TABLE 4

Prevalence of intestinal parasites in Middle Eastern and South Asian refugees, 2001–2004 versus 2008–2010, diagnosed by stool microscopy*

	2001–2004		2008–2010		
	Persons infected	%	Persons infected	%	*P* value
Middle East	*N* = 132		*N* = 721		
Protozoa	17	12.9%	52	7.2%	0.08
Helminths	3	2.3%	1	0.1%	0.01
South Asia	*N* = 167		*N* = 111		
Protozoa	11	6.6%	33	29.7%	< 0.001
Helminths	18	10.8%	3	2.7%	0.02
Africa	*N* = 142		*N* = 120		
Protozoa	16	11.3%	18	15.0%	0.37
Helminths	12	8.5%	5	4.2%	0.21
TOTAL	*N* = 533		*N* = 1232		
Protozoa	51	9.6%	126	10.2%	0.67
Helminths	33	6.6%	28	2.3%	< 0.001

*Eastern Europe, East Asia, and Southeast Asia comparisons not done because of insufficient participants and/or infected persons in one or both cohorts.

Based on stool O&P results, there was significant regional variability in the distribution of intestinal parasites. The Middle East had the lowest prevalence of both protozoa (7.2%) and helminths (0.1%). South Asia was the region with the highest prevalence of protozoan infections (29.7%). Although *G. intestinalis* was the most prevalent protozoa in refugees from Africa, South Asia, and Southeast Asia, in the Middle East, *G. intestinalis* was third to *D. fragilis* and *E. histolytica/dispar*. With regards to helminth infections, Southeast Asia was the region with the highest prevalence (8.3%, predominantly hookworm), whereas the Middle East had no hookworm infection and the only helminth infection was *Hymenolepis nana*.

Infection risk factors differed for protozoa and helminths (Table 3). Decreasing age was associated with protozoa but not helminth infection. Neither sex nor education level was associated with protozoan infection. However, men and those with less than a high school education were three and four times more likely to have helminths, respectively. Refugees from the Middle East had the lowest likelihood of having either protozoa or helminths in their stool. Compared with them, South Asians were three times more likely to harbor protozoa, and refugees from all geographic regions were much more likely to have helminths. Year of arrival in the United States was also a significant risk factor for both protozoa and helminth infections. The risk was highest in those arriving in the year 2008.

Comparison with 2001–2004 historical cohort. We compared the prevalence of intestinal protozoa and helminths in recent Middle Eastern refugees with the prevalence seen in similar refugees from 2001 to 2004 based on stool ova and parasite results (Table 4). Helminth infections decreased in all geographical regions, but most markedly in refugees from the Middle East, where a 95% reduction was observed from 2.3% to 0.1%. The prevalence of helminth infections also fell significantly in South Asia, by 75%. Overall, the proportion of refugees with protozoan infections remained unchanged, but depended on the region of birth of the refugees. Prevalence of protozoa decreased in the Middle East, and more than quadrupled in South Asia. African refugees continued to have the same rate of protozoa infections. In refugees from the Middle East, the prevalence of *G. lamblia* specifically decreased from 8.3% to 1.6%. The increase in protozoan infections in South Asian refugees was driven primarily by the high prevalence of *Giardia* infections in Bhutanese refugees (13.2% of those tested, 47.6% of the infected). There were no refugees from Bhutan in 2001 to 2004, but they comprised 61.8% of South Asians infected with protozoa in 2008 to 2010.

Results of *Strongyloides* and *Schistosoma* serology tests. To examine the extent of possible missed diagnoses of *Strongyloides* and *Schistosoma* spp., we tested serologies for these parasites in a subset of 238 adult refugees. Although stool O&P identified only 2 individuals with *Strongyloides* and none with *Schistosoma*, serology identified 56 individuals with *Strongyloides* (23.5% of 238 tested, Table 5), and 18 individuals with *Schistosoma* (7.6% of 238 tested). *Strongyloides* serology was positive in both persons who had positive stool O&P. The 56 refugees who had positive *Strongyloides* serology were from Iran (*N* = 20, 21% of Iranians tested), Bhutan (*N* = 10, 67%), Iraq (*N* = 8, 21%), Ethiopia (*N* = 7, 50%), Burma (*N* = 6, 30%),

TABLE 5

Characteristics of refugees with positive serology for *Strongyloides* or *Schistosoma* spp. among 238 refugees who were tested*

	Africa	South Asia	Southeast Asia	Middle East	South & Central America	Total
Number tested	29	27	40	136	2	238
Strongyloides+	9 (31%)	10 (37%)	8 (20%)	28 (21%)	1 (50%)	56 (24%)
Male	8 (33%)	6 (32%)	6 (23%)	12 (15%)	0	32 (21%)
Female	1 (20%)	4 (50%)	2 (14%)	16 (30%)	1 (100%)	24 (29%)
Age						
18–25	1 (14%)	6 (40%)	2 (13%)	9 (23%)	0	18 (23%)
26–35	4 (31%)	3 (30%)	2 (13%)	13 (19%)	1 (50%)	23 (21%)
36–45	4 (44%)	1 (50%)	4 (50%)	5 (19%)	0	14 (30%)
46–55	0	0	0	1 (33%)	0	1 (25%)
Stool O&P+	0	0	2	0	0	
Schistosoma+	5 (17%)	3 (11%)	5 (13%)	5 (4%)	0	18 (8%)
Male	4 (16%)	3 (16%)	2 (8%)	0	0	9 (6%)
Female	1 (20%)	0	3 (21%)	5 (9%)	0	9 (11%)
Age						
18–25	0	1 (7%)	3 (20%)	2 (5%)	0	6 (8%)
26–35	5 (38%)	2 (20%)	1 (6%)	2 (3%)	0	10 (9%)
36–45	0	0	1 (13%)	1 (4%)	0	2 (4%)
46–55	0	0	0	0	0	0

* % = positive persons/persons tested × 100. Four East Asians tested and with all negative results are not represented.

Eritrea (N = 2, 18%), Cuba (N = 1, 50%), Thailand (N = 1, 100%), and Vietnam (N = 1, 5%). The 18 refugees with positive *Schistosoma* serology were from Iran (N = 4, 4%), Eritrea (N = 3, 27%), Vietnam (N = 3, 16%), Bhutan (N = 2, 13%), Burma (N = 2, 10%), Ethiopia (N = 1, 7%), India (N = 1, 50%), Iraq (N = 1, 3%), and Somalia (N = 1, 50%). Fourteen of the African refugees tested for *Schistosoma* immigrated to the United States after overseas presumptive therapy with praziquantel was initiated in sub-Saharan Africa. Only four of them were positive. Three (5.4%) persons with positive *Strongyloides* antibodies (including 1 person with *Strongyloides* in the stool) had eosinophilia. Only 1 (5.6%) person with positive *Schistosoma* antibodies had eosinophilia.

DISCUSSION

A recent large study by the CDC showed that the rate of helminth infections in refugees from Africa and Southeast Asia decreased from 20.4% to 4.7% after the first recommendation for overseas treatment with single-dose albendazole.[15] In our study of refugees relocating to Northern California, helminth infections appear to be rapidly disappearing from the Middle East and South Asia as well. Although we have no data for the extent of overseas treatment, helminths were less likely to be found in refugees arriving in 2010 versus 2008, after adjusting for all other recorded variables including region of birth. These findings are consistent with a possible effect from the implementation of overseas albendazole treatment of refugees from the Middle East and South Asia.

Our results support the use of serology rather than stool O&P to diagnose *Strongyloides* and *Schistosoma* spp. infections—the two parasites that cause the greatest morbidity and mortality among refugees. Even though stool examination is the gold standard for screening refugees for intestinal parasites, our data are consistent with the literature reporting increased sensitivity of serology for the diagnosis of these two infections specifically.[6,16] In 2005, in an effort to improve the overseas treatment of *Strongyloides* and *Schistosoma* spp., the CDC expanded the recommended drug regimen with ivermectin and praziquantel. However, because of funding constraints, these changes were not implemented until more recently. Ivermectin has only been used since July 2011 in Burmese refugees emigrating from Thailand. Praziquantel was not started until January 2010. Therefore, the positive serologies in our study are likely true infections despite the negative results from stool microscopy. Four refugees from sub-Saharan Africa had positive *Schistosoma* serology and immigrated to the United States after the initiation of praziquantel overseas treatment in January 2010. We do not know if these positive results are in fact false positives (residual positive antibodies after treated infection) because we do not know if the refugees actually received praziquantel. The disadvantage of only using serology in refugees with no documentation of overseas treatment is possible overdiagnosis because antibodies can persist transiently before waning for *Strongyloides* and persist indefinitely for schistosomiasis after treatment.[17,18] However, repeated serology testing after some time has elapsed could help clarify the diagnosis, perhaps even for *Schistosoma* infection as scientists develop newer assays for antibodies that wane with time after treatment.[19–22] The presence of eosinophilia may help confirm infection with positive serology, though because it is often transient and rarely found, its absence cannot exclude infection.

The two protozoa in our study that cause the most morbidity were *G. lamblia* and *Entamoeba histolytica*. Although we found a high prevalence of *Giardia* infections among the refugees, particularly those from South Asia and Africa where the prevalence was 12.6% and 10%, respectively, our findings suggest that routine stool O&P is also probably unnecessary. More than three fourths of *Giardia* infections are asymptomatic, and it is not clear whether asymptomatic infection is detrimental to the host and by extension, whether treatment is beneficial.[23,24] In children, perhaps some of the most vulnerable to infection, the indications for screening and treatment are the most controversial. For example, although some studies found that subclinical or asymptomatic *Giardia* in children was associated with growth delay, failure to thrive, or carbohydrate malabsorption, various other groups found no ill effects.[25–27] Furthermore, other investigators report a possible protective effect with decreased gastrointestinal and respiratory illnesses among daycare children with asymptomatic *Giardia* infection.[28,29] From a public health perspective, there have been no reported incidents of *Giardia* outbreaks originating from refugees. For those with symptomatic *Giardia* infection, diagnostic testing—rather than screening tests—can be done, although even in this group, disease is usually self-limited.[30] Perhaps a conservative approach could be to only test adults with symptoms and children regardless of symptoms. *E. histolytica/dispar*, the second protozoan to cause the most morbidity, had a low overall prevalence in our study (2.1%). This number also overestimates the true prevalence of *E. histolytica* because microscopically, the organism is indistinguishable from the non-pathogenic *E. dispar*. Furthermore, *E. dispar* is far more common than *E. histolytica*, making up to 90% of *E. histolytica/dispar* reported.[6] For both *Giardia* and *E. histolytica*, stool antigen tests or PCR-based tests are more sensitive and accurate than stool microscopy.[31–33] Whether to replace stool O&P examinations with antigen testing for all refugees, only in those with symptoms, or only in children, needs to be evaluated.

Our finding of exceedingly rare helminth infections identified through stool O&P exams is consistent with the current CDC recommendation to omit domestic screening with stool O&P in refugees with documentation of pre-departure anti-helminthic treatment. Furthermore, our findings suggest that even in the absence of this documentation, routine screening stool O&P may no longer be necessary for most refugees. Instead, symptom-based testing, or targeted screening according to region of birth may be more appropriate. For example, Southeast Asians had the highest rate of hookworm infections, and selected stool O&P in these refugees might lead to higher diagnostic yield than routine screening O&P for all refugees without documentation of overseas treatment.

Our study was limited by the absence of data for overseas treatment. We also lacked data on symptoms that could have informed the clinical significance of directed stool O&P exams. We had limited serology data in adults and none in children, who have the highest risk for long-term sequelae of chronic intestinal parasites from missed diagnoses. Furthermore, we know very little about intestinal parasites in recent East Asian refugees as a result of their very low participation rate in the RHAP. Finally, we describe patterns of infections based on broad geographic regions, but recognize that refugees from specific countries can deviate significantly from the group, and their influx depends on not wholly predictable global political climates.

In conclusion, helminth infections are rapidly decreasing in refugees settling in Northern California. Although *Giardia* infections are still prevalent in some groups of refugees, routine screening stool microscopy, especially in adult refugees, is probably unnecessary. Evaluation of the feasibility and cost-effectiveness of new domestic screening protocols, such as symptom-based testing, serology, and/or stool antigen testing for intestinal parasites is warranted.

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