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ORIGINAL PAPER

Screening for Intestinal Parasitic Infections Among Myanmar Migrant Workers in Thai Food Industry: A High-Risk Transmission

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Abstract The impact of intestinal parasitic infections on public health has been neglected. Millions of Myanmar natives have migrated to work in Thailand. We performed a study of intestinal parasitic infections in Myanmar-migrants working in the Thai food industry. A total of 338 Myanmar migrant workers in a food plant at Samut Sakhon Province, Thailand, were recruited for this study. 284 (84%) returned requested stool samples. Samples were examined for intestinal parasites by means of simple smear, formalin-ether concentration, Locke-Egg-Serum medium, and Harada-Mori culture methods. We found parasites in 177 (62.3%) migrants (29 of 46 males; 148 of 238 females). The majority (89.3%) were infected with parasites transmitted by fecal-oral route, including *Blastocystis hominis* (41.5%), *Trichuris trichiura* (22.2%), *Giardia lamblia* (14.1%), and *Ascaris lumbricoides* (1.8%). Mixed infections were common (40.7%). The highest prevalence (73.3%) was found among migrants from Kohsong city, Myanmar. This high parasite infection rate in Myanmar migrant workers is an obvious public health hazard.

Keywords Intestinal parasites · Myanmar-migrant workers · Food industry · Thailand

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Introduction

Parasitic infections are a major public health problem worldwide, particularly in developing countries [1]. Intestinal parasitic infections are most common and with high prevalence in Thailand and Myanmar [2–11]. The impact of these infections on public health has been mostly ignored. An epidemiological survey showed that parasitic infections affect more than 35% of the Thai population [2]. However, the prevalence of intestinal parasitic infections varies from one area to another. This depends on the degree of personal and community hygiene, sanitation and climatic factors [12]. The prevalence of intestinal parasitic infections among Thai workers who visited the outpatient department of King Chulalongkorn Memorial Hospital, Bangkok is 6.1% [9]. This prevalence is lower than the average prevalence in remote areas of Tak and Khon Kaen provinces (46–72% and 34%, respectively) [5–7]. This is due to better health education and good access to health care facilities in urban areas. Furthermore, most city dwellers work in an office or industry where there is an adequate sanitary system.

Currently, there are mass migrations from less developed to more developed countries. Migrations not only cause large shifts in global population but also create new public health problems. This is reflected by the appearance of tropical diseases in developed countries such as malaria in the United States [13] and tuberculosis in Sweden [14]. Stool examination for parasites by simple smear technique is an important part of the health-screening program for migrants in some countries (e.g. USA [15] and Taiwan [16]). Intestinal parasitic infections are common in migrants with rather high prevalence (8.2–60%) [17–20]. In the USA, the highest rates were found among migrants from Southeast Asia (29.5%), and Africa (25.1%) [19].

An oppressive government and poor economy in Myanmar have resulted in immigration and establishment of refugee camps along the Myanmar–Thai border. Time spent in refugee camps may contribute to the prevalence of intestinal parasites and an overall compromised health status. The rapid extension of industrialization in Thailand also causes millions of migrant workers to migrate to urban areas of Thailand, particularly in industrialized provinces which require more laborers [21, 22]. Among the registered migrant workers, 6.1% are from Myanmar [21]. More than 60,000 migrants work in the food industries [21]. It is a major economic sector in Thailand, constituting 14.1% of the country's total exports [23]. Data from the Ministry of Public Health show that these migrants carry diverse infectious diseases (e.g. acute diarrhea, malaria, lymphatic filariasis, pneumonia, food poisoning, dengue fever, tuberculosis, etc.) [24–27]. Migrants often have poor access to government healthcare services which creates public health problems [28]. Registered migrants have to pass a health-screening program for mental retardation, tuberculosis, leprosy, elephantiasis, syphilis, drug addiction, and alcoholism [29]. However, intestinal parasitic infections are not included in the screening protocol. The prevalence of intestinal parasitic infections among the migrants in Thailand has never been reported.

Contaminated food and drink are common sources of intestinal parasitic infections. Migrant workers in the food industries may contribute to a re-emergence of infections and affect Thailand's public health as they are involved in every process including preparing, packing and transporting food items.

We investigated intestinal parasitic infections among Myanmar-migrant workers in a food factory and compared different techniques for identifying parasitic infestations.

Methods

Study Area and Population

A cross-sectional survey was conducted in a food production plant at Samut Sakhon Province, Thailand (Fig. 1). The province is an industrial area, located about 28 km southwest of Bangkok and is in a region with extensive food industries. There also is a large community of Myanmar workers [30].

This study was approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University, Bangkok. We recruited 338 food industry workers in cooperation with the Ministry of Labor and Social Welfare. Verbal informed consent was obtained from each individual in the presence of two witnesses. The interview process was performed through an interpreter. Methods for prevention

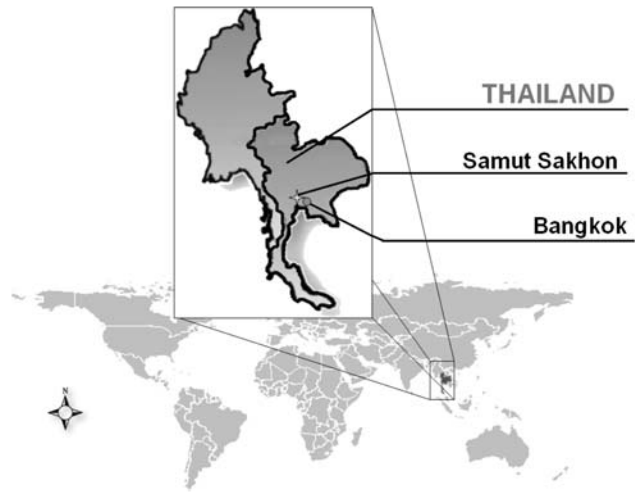

Fig. 1 The study area at Samut Sakhon Province (✦), Thailand

of common parasitic diseases such as consumption of only well-cooked food and safe water, hygienic defecation and avoidance of bare-foot walking outdoors were explained to all participants.

Stool Examinations

Cartons were distributed to participants the day before specimen collection. To avoid contamination, all subjects were shown how to collect and handle stool specimens before sending them to the laboratory. Stool examinations were performed by simple smear, formalin-ether concentration, Boeck and Drbohlav's Locke-Egg-Serum (LES) medium culture, and Harada-Mori filter paper strip culture for the presence of intestinal parasite eggs or larvae as described previously [4–10, 31]. About 2 mg of each stool specimen were examined microscopically by using a simple smear technique. LES medium was used to culture protozoa. The Harada-Mori culture method was used to identify hookworms and *Strongyloides stercoralis*. The rest of each specimen was processed by formalin-ether concentration. The presence of intestinal parasite eggs, larvae, or cysts was determined microscopically. Samples were independently examined by two examiners. Individuals who were infected were treated using albendazole (for *A. lumbricoides, S. stercoralis*, *T. trichiura*, hookworms, and minute intestinal fluke), or with metronidazole (for *B. hominis*, *G. lamblia*).

Data Analysis

Data were analyzed using Microsoft Excel 6.0 program and SPSS 11.5 for Windows. Numerical data were summarized as mean ± sd. Differences of the data and association between techniques were analyzed by chi-square or Fisher

Exact test. P values < 0.05 were considered statistically significant.

Results

Study Population

A total of 338 Myanmar-migrant workers were recruited but only 284 (84.0%) individuals returned stool specimens. Out of 284 individuals, 46 (16.2%) were male, and 238 (83.8%) female. Ages of participants ranged from 18 to 41 years (mean $\pm$ sd $= 23 \pm 4.6$ years).

Prevalence of Intestinal Parasitic Infections in Myanmar-Migrant Workers

Out of 284 individuals examined, 177 (62.3%, 29 males; 148 females) were infected with at least one intestinal parasite (Table 1). No statistically significant difference between the prevalence of intestinal parasites was found among each age group ($P = 0.107$) (Table 1) and both genders ($P = 0.757$) (63.0% males, 62.2% females) (data not shown). The highest prevalence of intestinal parasites was found in migrants from Kohsong City (73.3%) with statistical significance ($P = 0.01$; Table 2).

Table 1 Prevalence of intestinal parasitic infections among Myanmar migrant workers classified by age

Age group (years)	No. of examined	No. of positive* (% prevalence)
18–25	214	131 (61.2)
26–33	60	37 (61.7)
34–41	10	9 (90.0)
Total	284	177 (62.3)

* No significantly difference among the age group ($P = 0.107$)

Blastocystis hominis Infection was the Most Common Intestinal Parasite Found

Blastocystis hominis was found in 41.5% of subjects (Table 2). Non-pathogenic protozoa, *Entamoeba coli*, *Entamoeba nana*, and *Trichomonas hominis*, were found with a prevalence of 9.2, 5.6, and 2.8%, respectively (data not showed). Classified by the routes of transmission, the majority of patients (89.3%) were infected with parasites transmitted by fecal-oral route (i.e. *B. hominis, G. lamblia*). Soil-transmitted helminthes (i.e. *A. lumbricoides, T. trichiura, S. stercoralis,* and hookworm) were found in 40.7% of patients, while fish-borne parasites (i.e. intestinal flukes) were found in 7.9% of patients (data not showed).

Mixed Parasitic Infections were Common

Among 177 infected cases, 72 (40.7%) had mixed parasitic infections (Table 3). Seventy-five percent had 2 species, 22.2% had 3 species, and 2.8% had 4 species of intestinal parasites. Among the mixed infections, the combination of *B. hominis* and *G. lamblia* was most common (29.2%). This was

Table 3 Mixed infections of the intestinal parasites among 284 Myanmar migrant workers classified by the techniques for parasite identifications

	No. of positive (%)		
	Total	Simple smear	Formalin-ether concentration
Single infection	105 (59.3)	59 (56.2)	96 (91.4)
Mixed infections	72 (40.7)*	10 (13.9)	47 (65.3)
2 Infections	54 (75.0)	10 (18.5)	41 (75.9)
3 Infections	16 (22.2)	0	4 (25)
4 Infections	2 (2.8)	0	2 (100)
Total	177	69 (39.0%)	143 (80.8%)

* Significantly higher than by the simple smear ($P = 3.87 \times 10^{-8}$)

Table 2 Prevalence of intestinal parasitic infections among Myanmar migrant workers classified by the parasites and residence cities in Myanmar

Residence cities in Myanmar	No. of examined	No. of positive (%)	Identified parasites (%)						
			Bh	Tt	Gl	Hw	Mn	Al	Ss
Kohsong	15	11 (73.3)*	8	4	2	2	1	1	0
Dawai	45	31 (68.9)	20	10	8	5	0	0	0
Rangoon	143	97 (67.8)	64	37	17	15	9	3	2
Mawlamyine	52	24 (46.2)	17	6	10	2	4	0	0
Undocumented	29	14 (48.3)	9	6	3	0	0	1	1
Total	284	177 (62.3)	118 (41.5)	63 (22.2)	40 (14.1)	24 (8.5)	14 (4.9)	5 (1.8)	3 (1.1)

Bh = *Blastocystis hominis*; Tt = *Trichuris trichiura*; Gl = *Giardia lamblia*, Hw = Hookworms; Mn = Minute intestinal flukes; A = *Ascaris lumbricoides*; and, Ss = *Strongyloides stercoralis*

* Significantly higher than the other residence cities ($P = 0.01$)

Table 4 Sensitivity of the techniques for parasite identifications

Parasites	No. of positive (%)				
	Total	Simple smear	Formalin-ether concentration	LES culture	Harada-Mori culture
Protozoa					
B. hominis	118	25 (21.2)	89 (75.4)	49 (41.5)	ND
G. lamblia	40	25 (62.5)	35 (87.5)	6 (15.0)	ND
Helminths					
T. trichiura	63	16 (25.4)	51 (81.0)	ND	ND
Hookworms	24	6 (25.0)	10 (41.7)	ND	11 (45.8)
Minute intestinal flukes	14	4 (28.6)	10 (71.4)	ND	ND
A. lumbricoides	5	2 (40.0)	1 (20.0)	ND	ND
S. stercoralis	3	1 (33.3)	0	ND	2 (66.7)
Total[a]	177	69 (39.0)	143 (80.8)	52 (32.9)	13 (48.1)

ND: Not determined

[a] The total number of infected individuals detected by each technique is not equal to the sum of infected individuals with each parasite because some subjects have mixed infections with more than one parasite

followed by combination of *B. hominis* and *T. trichiura* (22.2%) (data not showed). The second most prevalent combination consisted of a fecal-oral and soil-transmitted parasite. The formalin-ether concentration technique could identify more mixed infections (65.3%) compared to a simple smear (13.9%) ($P < 0.001$) (Table 3).

Comparative Study of Different Techniques for Detecting Parasites

Out of 177 infected individuals, 69 (39.0%) had intestinal parasitic infections by simple smear technique, while 143 individuals (80.8%) were identified by formalin-ether concentration technique (Table 4) which was two-fold more sensitive than the simple smear technique. The sensitivity for detection of hookworm was increased by Harada-Mori filter paper strip culture (45.8% compared to 41.7% by formalin-ether concentration technique, and to 25.0% by simple smear technique). Harada-Mori filter paper strip culture could also identify more *S. stercoralis* infected patients (66.7%) than the simple smear (33.3%) (Table 4). Using the LES medium culture, we could identify protozoan infected patients (40.0%) less often than by using the concentration technique (95.4%). This was still more than by using the simple smear technique (36.2%) (Fig. 2). However, out of 130 protozoan infected patients, 15 (11.5%) were not detected by the simple smear and formalin-ether concentration, but could be identified using LES medium culture (Fig. 2).

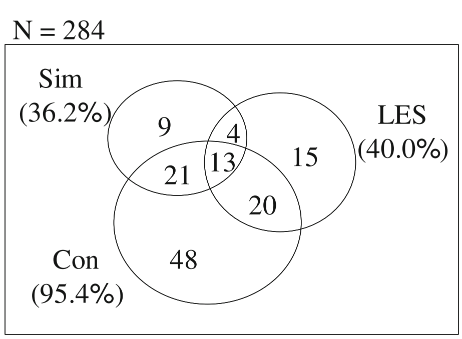

Fig. 2 Venn diagram showing patterns of detections for protozoan infections by simple smear (Simple), Formalin-ether concentration (Conc.), and Boeck and Drbohlav's Locke-Egg Serum (LES) medium culture. Numbers in circle indicate the numbers of positive cases. Numbers in parenthesis indicate the sensitivity of each technique for protozoan identification. N = Total number of the samples examined

Discussion

Our study showed that 62.3% of Myanmar migrant workers harbored at least one intestinal parasite (Table 2). This prevalence was much higher than the parasitic prevalence in Thai urban workers (6.1%) [9]. It is likely due to poor sanitation among migrant workers and an overcrowded housing environment (unpublished data). Our data also agree with several studies which showed that intestinal parasitic infections are common among migrants in many countries (8.2–60%) [17–20]. However, there are no recent data on prevalence of intestinal parasitic infections in Myanmar. The Myanmar government claimed improved sanitation since 1997 [32]. However, parasitic infections appear to persist in Myanmar [33]. Migrants usually come from low socioeconomic conditions and it is likely that our data represent the prevalence of intestinal parasitic infections in that social strata of Myanmar. The highest prevalence (73.3%) was found among migrants from Kohsong City, which is located at the border crossing point between Thailand and Myanmar. This region appears to represent the added risk of spreading parasitic infections to Thai people.

The parasites commonly identified among the migrants were different from those seen among the Thais. *B. hominis*

(41.5%), *T. trichiura* (22.2%), and *G. lamblia* (14.1%), were found frequently in migrants (Table 2). These parasites are also common among Southeast Asian laborers working in other countries [17–19]. In contrast, the parasites commonly identified in Thais are *A. lumbricoides* (16–49%), hookworms (22–38%), *S. stercoralis* (4–33%), and *Opisthorchis viverrini* (12–24%), while *B. hominis*, *T. trichiura*, and *G. lamblia* are found with low prevalence [2, 5–8]. The reasons for this difference may be directly related to specific geographic characteristics, as well as to ecological, sanitary, socioeconomic, and cultural factors [12].

Among the Myanmar migrants, the fecal-oral transmitted parasites (i.e. *B. hominis*, *G. lamblia*) were common (89.3%). Both *G. lamblia* and *B. hominis* are common causes of diarrheal outbreaks via food and drink [3, 34]. Therefore, sanitary latrines, clean water and well-cooked food consumption need to be promoted further. Soil-transmitted helminthes (i.e. *A. lumbricoides, T. trichiura, S. stercoralis,* and hookworms) were also found in migrants with high prevalence (53.7%).

A recent study noted that human *Taenia* species are occurring in the areas close to the Thailand–Myanmar border [35]. However, *Taenia* infections were not found in our study of Myanmar migrant workers. This may be due to the fact that the prevalence of *Taenia* infection is low in Myanmar [36]. Myanmar migrant workers consume vegetables more frequently (unpublished data) when in Thailand. Interestingly, we could not detect *Entamoeba* spp., and common trematodiases including *Paragonimus* spp. in these Myanmar migrants. This may be due to the fact that the prevalence of *E. histolytica* infections in Thailand is rather low (0.1–0.3%) [37, 38]. Moreover, the formalin-ether concentration technique has a limited capacity to detect *Paragonimus* spp. [39], while zinc sulfate flotation detects the parasite with higher sensitivity. Future studies should include identification by molecular approaches, and the stool samples should be kept not only in formalin but also in ethanol [35].

Reliable diagnosis aids in surveillance for intestinal parasitic infections. Similar to previous studies, the sensitivity of the formalin-ether concentration technique (80.8%) was much higher than simple smear technique (39.0%) for the diagnosis of intestinal parasites [10, 40]. The highest sensitivity for the detection of hookworms and *S. stercoralis*is was by the Harada-Mori method (48.1%) when compared to formalin-ether concentration (37.0%) and simple smear (25.9%) techniques. However, the drawback for Harada-Mori method is the time consuming requirement (about 7 days) when compared to the concentration method (about 30 min) [40]. The Harada-Mori method is therefore recommended for patients with undiagnosed diarrhea where strongyloidiasis is a possibility [40]. Interestingly, the LES medium culture provided lower sensitivity (40.0%) to detect protozoa than the concentration technique (95.4%). It has been reported that the cultivation of luminal protozoa is usually less sensitive than the microscopic method [41]. However, our results showed that 11.5% of the protozoan-infected patients were diagnosed only by the LES medium culture, but not by the simple smear and concentration techniques (Fig. 2). Our data suggest that the simple smear technique is insufficiently sensitive to be used alone for screening for parasites. Moreover, current methods of identification require time-consuming, labor-intensive techniques. Molecular tools for identification of parasitic infections, such as hookworm [42], *Taenia* [43], or *Entamoeba* spp. [44] will be useful for differential diagnosis and epidemiological studies.

Conclusions

A high prevalence of intestinal parasitic infections was found among Myanmar migrant workers in the food industry. The poor socioeconomic conditions, overcrowding, poor sanitation, and difficulty to access medical services support such parasite transmission. The high prevalence of these infections among Myanmar migrant workers represents a public health risk for Thailand. Almost all identified parasites could be transmitted by consuming food or water. While diethylcarbamazine (DEC) is provided for migrants to control lymphatic filariasis, albendazole would also be useful for elimination of intestinal parasites. We suggest that the screening program for alien work permits should include a stool examination for parasites. Mass drug administration (MDA) with diethylcarbamazine and albendazole for alien food industry workers every 6 month might be useful for control of lymphatic filariasis and intestinal parasitic infections. This should include a subsequent study of albendazole on intestinal parasites when added to the lymphatic filariasis elimination program and to look for drug interactions of DEC and albendazole. Improvements in sanitation, personal hygiene, water quality, as well as basic health education (e.g. washing hands before work/meals, using sanitary latrines, wearing shoes, as well as avoiding consumption of uncooked or partially cooked fresh-water fish) should be stressed as part of work-permit processing. This may also be the right time to carry out a large-scale national survey of parasitic infections among the Thai population.

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