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RESEARCH ARTICLE

Current status of infectious diseases among migrants and non-citizens in Malaysia

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ABSTRACT

The mass movement of migrants to Malaysia for employment is one of the factors contributing to the emergence and re-emergence of infectious diseases in this country. Despite mandatory health screening for migrants seeking employment, prevalence records of infectious diseases amongst migrant populations in Malaysia are still within negligible proportions. Therefore, the present review highlights the incidence, mortality and overall status of infectious diseases amongst migrants' populations in Malaysia, which maybe be useful for impeding exacerbation of inequalities among them and improving our national health system thru robust and effective emergency responses in controlling the prevalent diseases found among these populations and maybe, Malaysian citizens too. Peer-reviewed articles from January 2016 to December 2020 were searched through online platform including SCOPUS, PubMed, Science Direct, and Google Scholar. Non-peer-reviewed reports and publications from ministry and government websites including data from related agencies were also scoured from in order to ensure that there are no cases being overlooked, as most published articles did not have migrants as the research subjects. A total of 29 studies had been selected in the final analysis. Migrants in Malaysia were at higher risk for tuberculosis, malaria, lymphatic filariasis, cholera, leprosy and leptospirosis. Lymphatic filariasis was still endemic among this population while thousand cases of TB and cholera had been reported among them due to cramp living conditions and poor sanitation in their settlements respectively. While malaria had gradually decreased and become sporadic, the influx of migrant workers had led to the rising of imported malaria cases. Low cases of leprosy had been recorded in Malaysia but a significant proportion of it was contributed by migrant workers. As for leptospirosis, studies found that there are prominent cases among migrant workers, which particularly highest within workers with lower educational attainment. Infectious diseases are still prevalent among migrants in Malaysia due to various interplay factors including their working sectors, country of origin, immunization status, type of settlement, impoverished living conditions, and language and cultural barriers that impeding access to health facilities.

Keywords: Migrants; Foreign workers; Infectious diseases; Review; Malaysia.

INTRODUCTION

Malaysia is a fast-growing nation due to progressive urbanization and the steady rate of economic expansion, and the country has become one of the top destinations for millions of migrants from neighbouring countries, seeking low and semi-skilled jobs coupled with higher living wages (Yi *et al.*, 2020; ILO, 2021). This mass movement of migrants has led to an upward trend of infectious diseases (Alasil & Abdullah, 2019) especially in migrants arriving from endemic countries. The main study population included in this review is migrant worker who could be defined as either non-Malaysian citizens or permanent residents permitted for employment on a temporary stay with visiting passes (MEF, 2014). Migrant workers are legally employable under a valid Temporary Employment Pass, issued by the Department of Immigration (MEF, 2014).

At the end of 2020, there were 1.48 million documented migrant workers in the country totalling 9.9% of the workforce (EPU, 2021). Most originate from the ASEAN region, including Indonesia, Myanmar, Vietnam, Philippines and Thailand, with the highest density of workers occurring in the states of Selangor, Johor and Sarawak (Yi *et al.*, 2020). Data from the Ministry of Human Resources (MOHR) indicated that the majority of foreign workers are mostly employed in urban-based industries, mainly the manufacturing and

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construction sectors with around 14% engaged in the service sector. In the service sector alone, migrant workers contribute to about one third of the workforce (Yi *et al.*, 2020).

Information on infectious diseases amongst migrant workers is limited not only due to a lack of studies but also the reluctance of migrant workers to seek self-treatment. Government mandated insurance schemes provide up to RM10k for hospital admissions and surgery, and maximum compensation payments of up to RM20k and above for permanent disablement, accidental death or disease acquired related to employment, yet it is surprising that many migrant workers and employers are still unaware of these health benefits (MEF, 2014; Nordin *et al*., 2018; SOCSO, 2020). Some migrant workers are also concerned about the rising cost of high medical fees in public hospitals (Uddin *et al*., 2020) whereas others assumed that language barriers may lead to the possibility of medication errors and poorly obtained consent for medical procedures (Loganathan *et al*., 2019).

In this study, we reviewed the available publications that focus on infectious diseases among migrants and non-citizens in Malaysia, and highlighted the prominent diseases found among them and also factors that affecting the occurrence of these diseases.

MATERIALS AND METHODS

Electronic search

Literature reviews were conducted on peer-reviewed articles, case reports and online platforms such as SCOPUS, PubMed, Science Direct and Google Scholar. A combination of significant search words and Boolean operators were applied using relevant keywords such as ("[disease]" [MeSH Terms] AND "migrant"[All Fields] AND "Malaysia"[All Fields]). The "[disease]" word was substituted with corresponding, endemic or epidemic infectious diseases in Malaysia, followed by the word "migrant'' and all related words such as 'non-Malaysian', 'non-citizen', 'migrant worker' and 'foreign worker'. Searches for government reports and articles were undertaken using the Google search engine, not only for terms used solely in titles of respective reports but also through citations in these articles.

Inclusion and exclusion criteria

The search on these online platforms was confined to a previous five-year time frame for better review of the health status amongst migrants in Malaysia. Online searches were also extended to websites of Ministry of Health (MOH) Malaysia, Ministry of Home Affairs (MOHA) Malaysia and Foreign Workers' Medical Examination Malaysia (FOMEMA) and also related statistical reports on migrant and mobile populations.

The eligibility of the studies was determined by a set of inclusion and exclusion criteria as per summarized in Table 1 below.

Table 1. Inclusion and exclusion criteria for study selection

Inclusion Criteria	Exclusion Criteria
Primary and secondary data	Tertiary and unpublished data
Has migrants or non-Malaysians as subject of interests	Does not have migrants or non-Malaysians as subject of interests
English or Malay publications	Studies in languages other than English and Malay
Publication period; 1 January, 2016 to 31 December, 2020	Publication before 1 January, 2016

Literature screening and selection

All articles, papers or reports obtained were chosen scrupulously through pre-selection of the titles and abstracts. Studies with irrelevant titles, inapplicable subjects and unrelated diseases were disregarded. Then, the abstracts of the remaining papers were screened and only those with the pre-determined criteria as mentioned above were selected. Subsequently, full-text articles of the included papers were retrieved and were read thoroughly. Figure 1 summarized the selection process including the reasons for exclusion criteria.

RESULTS AND DISCUSSION

From a total of 29 articles and reports selected, tuberculosis appeared to be the most frequently occurring disease. The overview of all selected articles was tabulated in Table 2. The infectious diseases covered in this study are i) vector-borne and zoonotic diseases (malaria, Japanese encephalitis and leptospirosis), ii) vaccine-preventable diseases (measles, influenza B, human papillomavirus, tuberculosis, neonatal tetanus and poliomyelitis), iii) food and waterborne diseases (salmonellosis and cholera), iv) parasitic infections (lymphatic filariasis, strongyloidiasis, leishmaniasis, toxoplasmosis, *Blastocystis* infection, giardiasis, cryptosporidiosis and *Entamoeba* infection) and v) close contact infections (syphilis and leprosy).

Vector-borne and zoonotic diseases

Malaria

Malaysia introduced the Malaria Eradication Program in the early 60's with a target of zero transmission by 2015 in the West Malaysia and by 2020 in East Malaysia. Malaysia had successfully achieved zero indigenous human malaria cases for the first time in 2018 and managed to maintain this achievement during the next year (MOH,

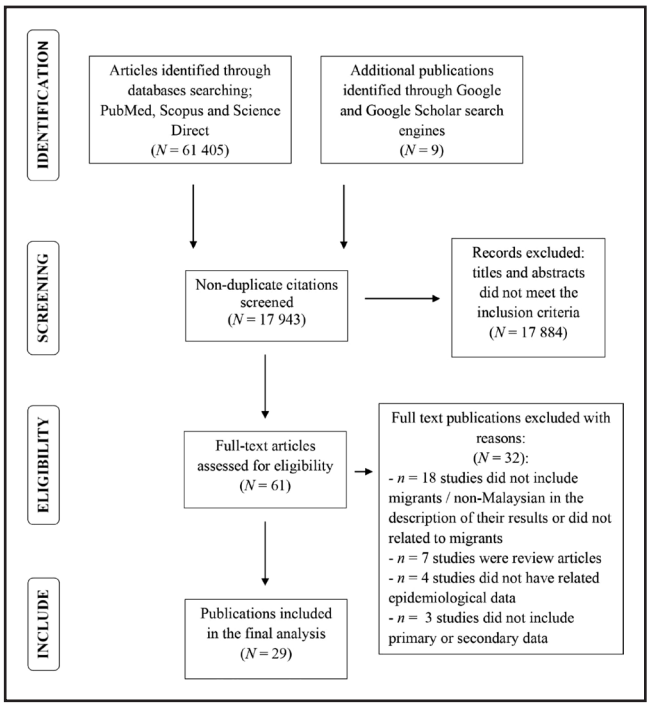

Figure 1. Selection process of manuscripts for the analysis on infectious disease among migrants in Malaysia.

Table 2. Overview of the finalized, selected studies and articles (n=29)

Diseases / Infectious agents	Study period	Study design / Study type	Subjects	Outcomes / Key findings	Study reference (author, year)
Vector-Borne & Zoonotic Diseases					
Malaria	June – December 2012	Retrospective, case control study	Two patients from a village Penampang, Sabah with *Plasmodium falciparum* malaria cases and 470 members from 79 households of the village.	- 11 (2.3%) cases of *Plasmodium falciparum* malaria were detected, one was an immigrant rubber tapper from Indonesia. - The key factor for those malaria cases was living near stagnant water with crude odds ratio (OR) = 6.5 [95% CI:1.2; 33.7]. - The outbreak was introduced by an Indonesian rubber tapper while the imported parasite was introduced to the community via vector *Anopheles balabacensis*.	Jeffree *et al.*, 2018
Malaria	2016 - 2017	Case series	Three malaria patient or cases admitted to urban, tertiary hospital in Klang Valley.	- All reported cases were imported malaria infections; a Nigerian foreign worker who had just returned from his hometown, a Nigerian student and a Filipino woman who had been unwell since returning from Cameroon. - All patients were infected by *P. falciparum*, a common cause of malaria in African countries.	MOH, 2016
Malaria	May – June 2020	Cases update and confirmation by Director-General of Health, Malaysia	Migrant workers involved in the construction of a highway in Ampang and the nearby residents	- 10 out 3,017 people that had been screened were positive and all of them were non-citizens. - A total of 13 cases among migrants were reported; 9 Indonesians, 3 Bangladeshis and 1 Nepalese. - The outbreak was suspected to be caused by an Indonesian worker who got the infection from his hometown, Acheh.	Abdullah, 2020b
Japanese encephalitis (JE)	2016	Reported cases gathered by Ministry of Health, Malaysia	Total number of Japanese encephalitis cases in 2016	- 49 reported cases in Malaysia, an increase of 13 cases (36.1%) as compared to 36 cases in 2015. - 7 of the cases (14.2%) were among foreigners.	Mohamed *et al.*, 2020
Leptospirosis	2012 - 2013	Retrospective, cross-sectional study	8,122 leptospirosis patients from the two-year period of study.	- 3,665 and 4,457 probable and laboratory confirmed leptospirosis cases notified in 2012 and 2013, and 1,126 (13.9%) of them were among foreigners. - Melaka had the highest age-standardized incidence rate (54.94 per 100,000) in 2012 while Selangor had the highest (24.68 per 100,000) in incidence rate in 2013. - Male preponderances were observed in this study.	Tan *et al.*, 2016
Leptospirosis	June 2014	Prospective, cross-sectional study	350 oil palm plantation workers in Melaka and Johor	- 100 out of 350 were seropositive for leptospiral antibodies. - 71.1% had either primary or secondary school education; 28.9% of them had no formal education. - 81.4% of the respondents were non-Malaysian.	Mohd Ridzuan *et al.*, 2016

Vaccine-Preventable Diseases					
Measles	2014 - 2018	Retrospective, cross-sectional study analysis of online measles surveillance systems collected data	48 outbreaks involving 124 cases, in Petaling district	- The incidence of measles outbreaks was low in non-Malaysian (4.8%). - Most measles outbreaks were found among unvaccinated children (55.6%) where most cases occurred at home (75.8%).	Rahman *et al.*, 2020
Influenzae B	August 2018 - May 2019	Prospective, cross-sectional study	436 healthy children aged 2–4 years from 30 registered childcare centres in Kuala Lumpur	- 7 children (1.6%) were non-Malaysian and all of them were *Haemophilus influenzae* negative carrier. - No statistical significance found using multivariable analysis. - The oropharyngeal carriage rates observed were low among healthy children aged 2–4 years old (5.5%, all were Malaysian).	Palaniappan *et al.*, 2020
Human papillomavirus	Not stated	Cross-sectional questionnaire-based survey, a randomized controlled trial	320 randomly selected African immigrant women (ages 18-69) attending opted church services in Klang Valley, Malaysia	- 60.3% of the respondents reported that they have never heard of cervical cancer and only 31 (9.7%) knows that HPV causes cervical cancer. - 67.2% never heard of Pap smear and majority of them claimed that they do not know the purpose of Pap smear. - The uptake of cervical cancer screening among the African women was very low, 27.2%.	Nwabichie *et al.*, 2018
Tuberculosis	2017	Reported cases gathered by Ministry of Health, Malaysia	Total number of notified TB cases in 2017 including new cases, relapse cases, treatment after default cases and treatment after failure cases.	- 3,133 out of 26,168 TB cases in Malaysia were among non-Malaysian, which is higher than previous year (2,978 cases).	MOH, 2017
Tuberculosis	2014 - 2017	Retrospective, cross-sectional study analysis of data from the Malaysian TB Information System (TBIS)	2,793 children in Kuala Lumpur, aged 0-14 years who were registered in the TBIS from 2014 to 2017, with at least one household contact of TB cases	- 11 out of 319 non-Malaysian children were positive with TB. - The prevalence of TB in children in Kuala Lumpur is lower than national prevalence. - Children who live with household contacts of TB cases aged < 5 years, positive TST and index-contact investigation period of > 6 weeks were associated with TB disease (high risk group).	Azit *et al.*, 2019
Tuberculosis	2013 - 2017	Retrospective, cross-sectional study data analysis from MyTB version 2.1	3,630 registered TB cases among children in Malaysia between 2013 and 2017 (final analysis is 3,550 due to missing data and change of final diagnosis)	- 479 TB cases (13.5%) were non-Malaysian where the highest proportion was from the Philippines (55.5%), followed by Indonesia (24.6%) and Myanmar (16.1%). All of these countries had high TB burden and low BCG coverage. - 36.5% of non-Malaysian citizens had BCG scars. - Determinant factors of treatment success among children with TB in Malaysia are citizenship status, being an older child and having BCG vaccine.	Awaluddin *et al.*, 2020

Tuberculosis	May 2013	Prospective, cohort study	482 legal, immigrant oil palm plantation workers in Sandakan, Sabah. Workers with previous history of TB or was currently on TB treatment were excluded from participation.	- No case of active TB detected among the 44 (9.1%) symptomatic participants. - Out of 44 participants with cough, only three (6.8%) of the participants had seek medical attention for their symptoms. - Participants in this study had had multiple annual medical examinations, which could be one of the reasons that none of the participants diagnosed with active TB during the study period.	Maini *et al*., 2016
Tuberculosis	2013 - 2017	Retrospective, cross-sectional study analysis based on registered TB cases diagnosed from hospitals and healthcare centres and demographic characteristics reported to Bintulu Health Office	1,175 TB cases from 2013 to 2017 in Bintulu	-168 of the cases were among migrants, mostly from Indonesia, followed by Philippines and India. - 29.4% of the TB patients were uneducated and 26.6% were only primary school level. - High number of TB cases were observed in male and unemployed groups. - The unexpected findings were more cases found in age range between 35-44 instead of children, 85.3% of the cases were non-diabetic patients and 60.7% of the patients coming from non-smokers group.	Masngut *et al.*, 2020
Tetanus	2017 - 2018	Reported cases gathered by Ministry of Health, Malaysia	Total number and incidence rate of neonatal tetanus cases in 2017 and 2018	- 16 cases in 2017, 15 of them were among non-Malaysians in Sabah. - 26 cases in 2018 with 6 reported deaths, 24 of the cases were among non-Malaysian citizens.	MOH, 2017, 2018
Poliomyelitis	2020	Cases update and confirmation by Director-General of Health, Malaysia	Polio cases among children in Sabah	- 3 out of 4 confirmed polio cases were among non-Malaysian children. - All of them had never been vaccinated since birth.	Abdullah, 2020a
Food and Waterborne Diseases					
Typhoid fever (*Salmonella* infections)	2011 - 2015	Retrospective, cross-sectional study data analysis from records in MOH's e-Notifikasi system and reported cases in public and private hospitals in Klang Valley, from 2011 to 2015	507 cumulative typhoid fever cases identified in the Klang Valley (265 – confirmed cases, 242 - probable and suspected cases)	- The increase of cases from 2014 to 2015 was due to an outbreak involving migrant construction workers. - 13.7% cases were contributed by foreigners (non-Malaysian) from India, Indonesia, Bangladesh, Myanmar and Nepal. - Most of the cases were detected in men and those within 21 to 30 years old. - Cases among foreigners were the third highest (14.4%) after Malay (52.1%) and Chinese (19.1%). - Transmission of typhoid fever is still prevalent in Klang Valley.	Muhammad *et al.*, 2020

Salmonellosis (*Salmonella* infections)	Not stated	Prospective, cohort study	317 migrant food handlers from 55 different food establishments in Ipoh, Shah Alam and Kuala Terengganu	- Nine (2.8%) migrant food handlers tested positive for the presence of *Salmonella*, who were males, originated from India, Nepal, Bangladesh, or Pakistan with a higher frequency in the age group 25-34 years. - The low prevalence of *Salmonella* may be because of the sample size, sample origin, type of fecal sample, or isolation methods used in different countries. - The positive findings could be linked to poor engagement in food training programs, language barrier and low educational background.	Woh *et al*., 2017
Cholera	2004 - 2014	Retrospective, cross-sectional study data analysis (data collected from MOH and Malaysian Metrological Department)	3,841 cholera cases with 32 deaths	- 29.7% of the cases were among immigrants in Sabah where some of cases were identified in illegal settlements with poor sanitation. - There was no significant difference in sex but young children (<12 years old) bore 45.1% of the cases. - The distribution of cases was coherent with the change of climate in Malaysia. - Most of the cholera cases in Malaysia occurred in the coastal states and the highest number of cases were in Sabah.	Hassan *et al*., 2020
Cholera	2018	Reported cases gathered by Ministry of Health, Malaysia	Total number of cholera cases in 2018	- 0.5 incidence rate per 100,000 population, an increase compared to the year 2017 (0.01 per 100,000 population). - 98.8% was from Sabah, which was contributed by non-Malaysian comprising 65.7% of the total cases in Sabah, especially among residents who did not have any valid identification document. - The main risk factors included unsafe water supply, poor hygiene and sanitation. - There was an imported cholera case reported in Selangor in the same year, which was introduced by a Bangladeshi worker who had just arrived in Malaysia.	MOH, 2018

Parasitic Infections					
Intestinal parasitic infections (Helminthiasis)	September 2014 – August 2015	Prospective, cross-sectional study	388 volunteers of migrant workers from five working sectors; manufacturing, construction, plantation, domestic and food services	- 62.9% were positive for intestinal helminths and protozoan infections (both helminths and protozoa combined. - Soil-transmitted helminth (STH) (68.3%) infections were more prevalent compared to protozoan infections (25.5%); *A. lumbricoides* (43.3%), hookworms (13.1%), *E. histolytica/dispar* (11.6%), *T. trichura* (9.5%), H. nana (1.8%) and *E. vermicularis* (0.5%). - Factors associated with high prevalence of parasitic infections were nationality, number of working years in Malaysia, type of employment sectors and anthelmintic treatment. - Transmission of intestinal nematode infections within the community depends on human behaviour (particularly during eating and defecation) personal hygiene and cleanliness.	Sahimin *et al.*, 2016
Strongyloides stercoralis infections / Strongyloidiasis (Helminthiasis)	September 2014 – August 2015	Prospective, cross-sectional study using microscopy, two types of ELISA and PCR	610 migrant workers from manufacturing, food services, construction, domestic services, agriculture and plantation. 483 and 388 provided blood and faecal samples. Only 306 provided both blood and faecal samples.	- No *S. stercoralis* larvae detected using microscopy, 6.4% were positive for both ELISA tests and 3 samples (2 from India, one from Indonesia) following microscopy were tested positive using PCR. - Higher seroprevalence were found in male, those originating from Myanmar and India, workers in food service sector, and those living on their own and in hostels.	Sahimin *et al.*, 2019b
Lymphatic filariasis (Helminthiasis)	September 2014 – August 2015	Prospective, cross-sectional study	484 migrant workers from five working sectors; manufacturing, service, agriculture and plantation, construction, and domestic work	- Positive cases were detected among workers from Nepal and Bangladesh, where brugian LF is not endemic. - Notable numbers of seropositive workers from India (~20%), Nepal (~13%) and Myanmar (7%), for brugian LF that were detected by BmSXP recombinant antigen.	Noordin *et al.*, 2017
Lymphatic filariasis (Helminthiasis)	2016 - 2017	Reported cases gathered by Ministry of Health, Malaysia	Total number of microfilaria cases reported and incidence rate in 2016 and 2017	- 271 positive microfilaria cases reported in 2016, which is 48.9% higher than previous year. - 86 of cases in 2016 were among migrant workers (57% Indian, 21% Nepalese, 13% Burmese and 7% Indonesian). - Notable parasite species detected among migrant workers were *W. bancrofti* (90.6%), subperiodic *B. malayi* (5.8%) and periodic *B. malayi* (3.4%). - In 2017, there were 308 filariasis cases reported and 45% of them were among migrants.	MOH, 2017; Mohamed *et al.*, 2020

Leishmaniasis (Protozoan infections)	Not stated	Prospective, cross-sectional study	2,153 asymptomatic immigrant workers working in the construction, manufacturing, farming, and agricultural sectors in selected areas in Peninsular Malaysia	- 55.3% were seropositive, with prominent prevalence in migrants from Nepal (68.6%), India (62.2%), Bangladesh (54.9%) and Myanmar (44.4%). - The workers were healthy with no signs and symptoms of visceral or cutaneous leishmaniasis, which might indicate that the high serum titer among the immigrant workers was acquired in the past. - No evidence of local parasite transmission despite the presence of apt vectors in Malaysia.	Noor Azian *et al*., 2016
Toxoplasmosis (Protozoan infections)	September 2014 – August 2015	Prospective, cross-sectional study	484 migrant workers from five working sectors; manufacturing, service, agriculture and plantation, construction, and domestic work	- The seroprevalence was 57.4%, and 53% had latent infection, indicative of previous exposure to *T. gondii*. - Two statistically significantly extrinsic factors associated with seropositivity are employment sector (manufacturing industry, 76.3%) and years of residence in Malaysia (recently arrived). - Two highly significant intrinsic factors associated with *T. gondii* infection among them; age class (> 45 years old) and migrant workers' countries of origin (highest among Nepalese (77.8%), followed by Indonesian (58.3%) and Bangladesh (45.8%).	Sahimin *et al*., 2017
Blastocystis infection and subtypes (Protozoan infections)	September 2014 – May 2015	Prospective, cohort study	220 migrant workers who had newly arrived and those who were already in the country for more than a year.	- *Blastocystis sp.* was detected 30.9% of the samples, and significant associated risk factors that affect the positive findings among participants was nationality and length of working years whereas as not much difference found among different employment sectors and gender. - *Blastocystis* infection and its symptomatology was highly influenced by the composition of gut microbiome (a local could have symptomatic infection, which was transmitted by an asymptomatic migrant, due to the difference in gut microflora).	Sahimin *et al*., 2020
Giardiasis and cryptosporidiosis (Protozoan infections)	September 2014 – August 2015	Prospective, cross-sectional study	388 migrant workers from five working sectors; construction, manufacturing, plantation, food service and domestic	- 10.8% were positive for *Giardia spp.* and 3.1% for *Cryptosporidium spp.* infections. - Significant factors associated with giardiasis; nationality (higher prevalence among Nepalese and Indonesian), employment sector and years of residence in Malaysia. - Higher probability of acquiring infections in their country of origin rather than after arrival in Malaysia.	Sahimin *et al*., 2018

Entamoeba infections (Protozoan infections)	September 2014 – August 2015	Prospective, cross-sectional study using microscopy, serology and molecular techniques	610 participants from migrant workers, where 484 (79.3%) provided blood and 388 (63.6%) faecal samples and 306 volunteers provided both blood and faecal samples	- Out of 306 participants, only 4 serum samples from 25 PCR positive faecal samples were positive for IgG4 to the rPPDK antigen. - *Entamoeba* positive participants did not exhibit any clinical symptoms. - There are significant associations between having *E. dispar* infections and working in food service or domestic sector.	Sahimin *et al.*, 2019a
Infections via Close Contact					
Leprosy	2017	Reported cases gathered by Ministry of Health, Malaysia	Total number of leprosy cases in 2017	- 74 out of 214 (35%) were among non-Malaysian. - High cases detected especially those from Indonesia, Philippines and Nepal which contribute 91% of new cases in 2018.	MOH, 2017
Syphilis	January 2010 – December 2012	Retrospective, analysis of patients with serologically confirmed syphilis cases	67 patients from UKMMC (41 males, 26 females), with serologically confirmed syphilis cases	- 20.9% of the patients comprised of Indonesian, Sikh, Pakistani and Burmese. - Most of the patients were asymptomatic at the time of diagnosis (latent stage of syphilis). - The mode of transmission wasunknown, sexually or via parenteral transmission (intravenous drug user).	Wahab *et al.*, 2018
Syphilis	2010 - 2015	Retrospective, analysis of patients with seropositive syphilis	379 patients in UMMC	- 305 patients were asymptomatic and 295 were positive HIV. - 5 non-Malaysian patients were included for treatment failure analysis and 4 of them had successful treatment	Kader *et al.*, 2020

2019). Despite this, Malaysia is still susceptible to malaria imported cases due to its geographical vicinity to endemic and high burden countries such as Thailand and Myanmar (Mohamed *et al*., 2020). In Malaysia, malaria is one of the mandatory notifiable diseases and is monitored weekly via a web-based surveillance system (vekpro-online) (MOH, 2016). Recent infections re-emerged in imported cases from endemic and high burden countries including Thailand and Myanmar (Mohamed *et al*., 2020). A retrospective study by Jeffree *et al*. (2018) identified a malaria positive case of *P. falciparum* in an Indonesian rubber tapper that spread to the community in a once free disease-free village. Similarly, case series of three imported malaria cases were detected from a Nigerian migrant worker, a Nigerian student and a Filipino woman, all with a history of travelling to African countries (Mohamed *et al*., 2020). As in 2019, the total of malaria cases reported in Malaysia are 96 introduced human malaria, 620 imported human malaria and 3,222 zoonotic malaria, with six deaths that all attributable to zoonotic malaria infections (MOH, 2019). In the mid-2020's there was an emergence of 14 cases in Ampang, Selangor, involving nine migrant workers from Indonesia, three from Bangladesh and one Nepalese but with no deaths were reported. These cases appeared to have originated from an Indonesian construction worker from Acheh, resulting in the spread of infection in co-workers and nearby residents (Abdullah, 2020b). These imported cases highlight the importance of undertaking a robust strategy to control and fully eliminate malaria transmission thus strengthening post-malaria surveillance. Among mitigations that can be implemented to control the malaria transmission are by ensuring all migrants had undergone malaria screening, keeping full record of workers going in and out of forest, increasing their accessibility to formal health service facilities and supplying migrant workers and their families with long and full covered clothes with gloves and scarves, burning incenses, insect repellent on skin and insecticide-treated nets.

Japanese encephalitis

Japanese encephalitis (JE) is included as a notifiable vector-borne disease under the Prevention and Control of Infectious Diseases (PCID) Act 1988. This virus is transmitted through the bite of a *Culex* mosquito and in severe cases infections can cause encephalitis in human and horses including abortion in sows (Kumar *et al*., 2018). In 2016, there were 49 sporadic JE cases with 3 deaths reported in Malaysia. From the total, 7 cases (14.2%) were identified among the migrants. This reported data showed an increment of 36.1% as compared to 36 cases in the previous year (MOH, 2016). The total number of reported cases recorded by the Ministry of Health in 2017, 2018 and 2019 were 23, 28 and 36 respectively, with seven fatalities recorded within this three-year period (MOH, 2017; 2018; 2019). The limited number of studies on JE has highlighted the potential risk of transmission of this virus amongst migrant workers in Malaysia.

Leptospirosis

Leptospirosis is a globally emerging, zoonotic disease caused by the pathogenic spirochete *Leptospira*. Rodents are the most common host reservoirs for this transmission taking place through contaminated mammalian blood or urine or indirectly through contaminated water or soil (Benacer *et al*., 2016). Leptospirosis is endemic in Malaysia, but surprisingly this was only regarded as a notifiable disease from 2010 onwards (Tan *et al*., 2016). Up to 3,665 and 4,457 cases of leptospirosis were respectively identified in 2012 and 2013 with a total of 1,126 cases (13.9%) reported in foreign workers (Tan *et al*., 2016). Transmission primarily occurs in agricultural and plantation workers, who are directly exposed to contaminated sources (Tan *et al*., 2016), with agriculture-based workers in China also demonstrating heavy infections of leptospirosis (Hartskeerl *et al*., 2011; Zhang *et al*., 2012). In addition, a study in Melaka and Johor reported a seropositivity of 28.6%, (100/350) in oil palm plantation workers, who were primarily non-Malaysian (Mohd Ridzuan *et al*., 2016).

Vaccine-preventable diseases

Measles

Measles is included in the Malaysia's National Immunisation Programme implemented to control vaccine-preventable diseases. This program has been ongoing for more than 60 years (MOH, 2016) and was revised in 2016 following an increase in the number of cases in children less than 1-year old. Between 2014 to 2018, 124 measles cases were reported in the Petaling district including 4.8% in non-Malaysian children (Rahman *et al*., 2020). The study had found that one of the imperative factors that causes the outbreak is being unvaccinated. Therefore, despite the relatively low incidence among non-Malaysian children, a complete immunisation programme for children is imperative to establish potent herd immunity in both local and migrant populations.

Influenza B

Prior to the introduction of *Haemophilus* influenza b (Hib) conjugate vaccine, Hib was one of the major causes of bacterial meningitis in children less than 5-years-old worldwide (Tsang & Ulanova, 2017). Clinical symptoms range from asymptomatic colonisation in the upper respiratory tract to mucosal infection and serious invasive disease (CDC, 2020). In Malaysia during the pre-vaccination era, Hib was responsible for about 50% of bacterial meningitis cases in major paediatric centres such as day care centres and nurseries (Hussain *et al*., 1998). Recently a cross-sectional study of 30 registered childcare centres in Kuala Lumpur reported that all seven non-Malaysian children out of 436 children involved in the study, were *H. influenza* negative carriers (Palaniappan *et al*., 2020). Although this disease is not prevalent among migrant population, continuous surveillance must still be conducted on this virus due to inconsistent influenza seasonal peaks so that vaccination and antiviral treatment can be provided efficiently to the susceptible individuals.

Human papillomavirus (HPV)

The Human papillomavirus (HPV) 16 and 18 are leading causes of cervical cancer, which is the fourth most common form of cancer among women worldwide (WHO, 2022a). In 2010 the Malaysian HPV immunisation programme focused on secondary school girls to prevent a rise in the incidence of cervical cancer among young women particularly (MOH, 2016) as prevention of cervical cancer can be attained through early and regular screening. A survey conducted by Nwabichie *et al*. (2018) among African immigrant women in the Klang Valley concluded that two thirds of respondents were unaware of the importance of Pap smear screening, with a low uptake of 27.2%. This was due to inadequate knowledge and understanding of cervical cancer screening which was lacking in their country of origin especially in West African countries such as Ghana and Nigeria (Adanu *et al*., 2010; Ekane *et al*., 2015; Nwabichie *et al*., 2018).

Tuberculosis

Tuberculosis (TB) is one of the leading mortalities causing infectious diseases worldwide (WHO, 2021). The burden of tuberculosis (TB) in Malaysia is still significant despite the inception of the National Tuberculosis Control Programme and BCG Vaccine Programme in 1961 (MOH, 2016). The total number of notified TB cases in Malaysia showed a reduction from 350 cases per 100,000 in the 1980's to 68 per 100,000 population and this has remained unchanged for the past three decades. However, the number of cases increased to 83.4 per 100,000 populations in 2016 with only a limited decline in 2018 (MOH, 2019). Relatively low TB prevalence of 13.5% were recorded among non-native children from 2013 to 2017 and surprisingly the number of migrant children originating from countries such as the Philippines, Indonesia and Myanmar with high TB burdens and low

BCG immunisation failed to present a visible BCG scar (Awaluddin *et al*., 2020). A similar study conducted in Kuala Lumpur between 2014 and 2017 reported 3.4% prevalence of TB cases among non-native children with the majority being less than 5 years old (Azit *et al*., 2019). In Bintulu, Masngut *et al*. (2020) reported 168 TB cases between 2013 to 2018, with mostly originating from Indonesia, Philippines and India. On the other hand, Maini *et al*. (2016) reported no active TB cases among symptomatic immigrant plantation workers in Sabah, largely due to strict mandatory annual medical examinations yet this contradicted findings from many studies where migrant workers were held responsible for high prevalence of active TB cases in Malaysia (Masngut *et al*., 2020). Overall, the total number of TB cases contributed by non-Malaysians were 2,978 and 3,133 in 2016 and 2017 respectively (MOH, 2017) suggesting that clearer guidelines for migrant workers are required on an inclusive vaccination policy, better ventilated housing and effective education on disease transmission.

Tetanus

Tetanus or lockjaw is caused by the bacterium *Clostridium tetani*, which results in painful muscle contractions in a person's jaw muscles and neck, leading to difficulty in swallowing and jaw cramping (CDC, 2019). For neonatal tetanus, the infection occurs in the region of the baby's umbilical stump, and can be fatal if the mother is not immunized against tetanus during the antenatal period (MOH, 2002). Over a two-fold increase of cases were reported in 2017 with 16 being neonatal tetanus cases and 15 cases identified among the migrant population in Sabah compared with only six cases in 2016 (MOH, 2017). In the following year, six tetanus deaths were reported with 24 of 26 cases in non-Malaysian (MOH, 2018). There were no attributable factors stated in the selected publications relating to the increase of tetanus cases among the migrants' population.

Poliomyelitis

Poliomyelitis or polio is highly contagious resulting in paralysis of the infected individuals. A child recovering from an initial infection may suffer from post-polio syndrome decades later as there is neither cure nor prevention from oral or injected vaccines (CDC, 2021). At the end of 2019, one polio case was first reported in Malaysia after almost two decades free from this disease. By 2020, four polio cases were reported in Sabah with three were among unvaccinated non-Malaysian children (Abdullah, 2020a).

Food and waterborne diseases

Salmonella infections

Salmonellosis or typhoid, which is a common foodborne disease, often associated with contaminated food preparation and commercially prepared foods, (Woh *et al*., 2017) is more prevalent in the east coast of Malaysia and rural areas, where access to the clean sources of water is limited (Muhammad *et al*., 2020) resulting in an annual incidence rate below 100,000/population (MOH, 2019). A retrospective, cross-sectional study reported that an increase in the number of typhoid cases in the Klang Valley from 2014 to 2015 was due to an outbreak among construction workers, originating mainly from Bangladesh, India, Myanmar, Indonesia and Nepal (Muhammad *et al*., 2020). Woh *et al*. (2017) reported a low prevalence of asymptomatic non-typhoidal *Salmonella* among Indian, Nepalese, Bangladeshi and Pakistani migrant food handlers (2.8% n=9), but even such a low prevalence of *Salmonella* amongst food handlers emphasises the importance of typhoid vaccination to limit the transmission of salmonellosis amongst local communities.

Cholera

Vibrio cholerae, the causative agent of this aquatic diarrheal disease, remains viable up to two to eight weeks in salt water and two weeks in fresh water (Hassan *et al*., 2020). Direct human transmission occurs via the faecal-oral route or indirectly through contaminated fluids (Deen *et al*., 2020). The incidence of cholera in Malaysia increased from 0.01 per 100,000 population in 2017 to 0.50 per 100,000 population in 2018 (MOH, 2018). Overall, the transmission of cholera is influenced by climate change, poor water supply and unhygienic practices, (MOH, 2018; Hassan *et al*., 2020) with the majority of cases particularly in Sabah, shown to be 65.7% amongst illegal migrants. In addition, between 2004 to 2014 up to 29.7% of cholera cases in Sabah were reported in residents from illegal settlements with poor sanitation, (Hassan *et al*., 2020) whereas in Selangor an imported cholera case was detected from a newly arrived Bangladeshi migrant worker to Malaysia (MOH, 2018).

Parasitic infections

Helminthiasis

Parasitic infections are prevalent among disadvantaged and underprivileged communities such as aborigines and migrant workers (Alasil & Abdullah, 2019). Several helminth infections such as lymphatic filariasis and soil-transmitted helminths (STH) appear to be endemic in migrant workers in Malaysia with *Ascaris lumbricoides* (43.3%) the most common infection followed by hookworm (13.1%) and *Trichuris trichiura* (9.5%) (Sahimin *et al*., 2016). High STH infections were observed in Nepalese and Indian workers who resided in Malaysia for less than a year, and without any evidence of anthelmintic treatment (Sahimin *et al*., 2016). Similarly, infections with *Strongyloides stercoralis* were reported among male workers from Myanmar and India (Sahimin *et al*., 2019b), whereas a study on the seroprevalence of lymphatic filariasis in 2017 showed that *Brugian filariasis* infections were prominent among Indian, Nepalese and Burmese workers (Noordin *et al*., 2017). These findings were in parallel with reports from the MOH in 2016, with 31.7% of 271 microfilarial cases reported in migrant workers primarily from India (57%), Nepal (21%), Myanmar (13%) and Indonesia (7%) (MOH, 2016). Dominant parasite species recovered included *Wucheraria bancrofti* (90.6%), sub-periodic *B. malayi* (5.8%) and periodic *B. malayi* (3.4%) (MOH, 2016), whereas in 2017 a total of 308 filariasis cases were reported with 45% occurring in migrants (MOH, 2017).

Protozoan infections

In 2016, a seroprevalence study of leishmaniasis showed high levels of infection among migrant workers from Nepal (68.6%), India (62.2%), Bangladesh (54.9%) and Myanmar (44.4%) (Noor Azian *et al*., 2016), though no evidence of local transmission was confirmed despite the presence of favourable vectors in Malaysia. On the other hand, Sahimin *et al*. (2017) reported more than half of migrant workers were seropositive with *Toxoplasma gondii* which was linked with the nature of employment, length of working years in Malaysia, nationality and age. In addition, high prevalence of infection with giardiasis, cryptosporidiosis and amoebiasis in migrant workers appeared to be linked with nationality and duration of employment of less than 1 year in Malaysia, (Sahimin *et al*., 2016, 2018, 2019a) with high *Blastocystis* infections also being reported in the intestinal tract of newly arrived Burmese workers (Sahimin *et al*., 2020). Therefore, educating migrant workers on good hygiene practices is essential in maintaining acceptable standards within the food industry.

Infections via close contact

Syphilis

Syphilis is a sexually transmitted disease caused by the spirochete *Treponema pallidum*. Clinical symptoms of syphilis are divided into several stages and late treatment will lead to severe clinical manifestations (Wahab *et al*., 2018). The accuracy of syphilis incidences in Malaysia is hampered by a low notification rate (Kader *et al*., 2020), and during 2010 to 2012 up to 14 of 67 seropositive syphilis patients in Universiti Kebangsaan Malaysia Medical Centre

(UKMMC) were diagnosed in non-Malaysian citizens. Most patients were asymptomatic or diagnosed with latent stages of syphilis (Wahab *et al*., 2018; Kader *et al*., 2020).

Leprosy

Leprosy or Hansen's disease is a chronic curable disease caused by *Mycobacterium leprae*. Human skin, peripheral nerves, eyes and the upper respiratory tract are normally affected but late detection and treatment often leads to permanent disability (WHO, 2022b), although in Malaysia, the incidence of leprosy is very low (MOH, 2017). A national leprosy elimination status was achieved in 1994, but infections remains endemic particularly in the states of Sabah and Pahang (MOH, 2018). In 2017, 35% of leprosy cases were reported among non-citizens particularly from Indonesia, the Philippines and Nepal, who also contributed approximately 91% of new leprosy cases for the following year (MOH, 2017) Grade 2 deformity and multibacillary leprosy cases were also recorded and these harbour higher bacterial loads comparable with paucibacillary leprosy (MOH, 2017). Therefore, early diagnosis and complete multidrug treatment must be strictly disseminated throughout local and migrant communities to reduce the burden of leprosy in Malaysia.

COVID-19 among migrants in Malaysia

Covid-19 was caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) with mild to severe symptoms ranging from fever, diarrhoea, conjunctivitis, loss of taste and smell. Transmission via aerosolised droplets affected people within close proximity of each other. By the end of February 2022, a total of 3,442,736 cumulative and 293,192 active cases were reported in Malaysia, with 32,749 (0.95%) cases resulting in death (MOH, 2022a 2022b).

In May 2020, a mass arrest of over 2,000 illegal foreign workers led to an increase in Covid-19 cases in detention centres (Wahab, 2020; ILO, 2021). An outbreak was also reported among migrants in a factory producing gloves with almost 50% of workers testing positive by the end of 2020 (ILO, 2021). A significant increase in the number of cases among foreign workers was primarily due to crowded living conditions. Malaysia's national news agency reported that up to 1.4 million migrant workers occupying housing provided by employers did not comply with the Workers' Minimum Standards of Housing and Amenities Act 1990 (Bernama, 2020) and this was mainly due to inequitable treatment by employers.

Factors associated with occurrence of infectious diseases among migrants in Malaysia and the other countries

Infectious diseases reported among migrants in Malaysia are mostly imported and endemic at their home countries (Noor Azian *et al*., 2016; MOH, 2017; Jeffree *et al*., 2018; Awaluddin *et al*., 2020; Chin *et al*., 2020; Mohamed *et al*., 2020). Furthermore, the migrant lifestyle, sanitation practices, type of accommodation, educational level and working sectors are among the contributed factors to the infections (Sahimin *et al*., 2016, 2019a; Woh *et al*., 2017; MOH, 2018; Nwabichie *et al*., 2018; Hassan *et al*., 2020; Masngut *et al*., 2020). On top of that, low rate of immunization and lack of awareness among these communities have become associated factors to the number of vaccine preventable diseases (Awaluddin *et al*., 2020). The low rate of immunization among these populations had also contributed to TB cases in this country (Awaluddin *et al*., 2020).

Singapore also faced similar problems with infectious diseases among migrants. Impoverished housing conditions and poor hygiene in crowded settlements are major contributors for increasing the transmission of airborne diseases (Koh, 2020). In addition, a study in China showed that demographic factors, socio-economic status, social security levels, behavioural and lifestyles (particularly smokers) are major risk factors affecting the health of migrant populations (He *et al*., 2019).

Similarly, in Russia communicable and non-communicable diseases together with co-occurring morbidities are widespread among vulnerable human populations. Factors contributing to the risk of disease include non-compliance with hygiene, scarcity of immunisation, malnutrition and poor living conditions. Furthermore, inadequate knowledge of safe sexual practices, low health-seeking behaviour and limited access to healthcare enhance the inadequate facilities experienced by migrants (Bakunina *et al*., 2020).

In developed nations such as the United States of America, the majority of immigrants are healthier than native-born citizens. However discriminatory policies have resulted in the deteriorating health status of migrants especially when children are separated from their parents. High costs, stricter procedures in seeking treatments, together with little or low access to early child education and nutrition, had played a role in the declining health status of the migrant families (Khullar & Chokshi, 2019).

Limitations of the study

The main limitation of this study is the use of secondary data, which depends upon the availability of the relevant parameters. Imperative parameters such as the migrants' nationality, their demographic background, and the economic and educational status of individual migrants are not always being made available. Therefore, it is impossible to provide an in-depth analysis of a particular infectious disease within specific groups of migrants. The diversity in reporting sub-population of migrants such as 'non-citizen', 'foreigner' or 'non-Malaysian' have also limited the comparability among studies. Additionally, since the included papers only consist of first-hand data gathered and generated by the researchers or data that had been already collected, this review may have overlooked significant unpublished data especially as individual migrants tend to undergo self-treatment rather than attend hospitals or clinics for a more specific diagnosis of their health status, hence affecting the generalizability and reliability of the whole results. Finally, in order to provide the current status of infectious diseases among migrants, the utilization of five recent years (2016 till 2020) in the search engines has been one of the factors that limits the sample size in the final analysis.

CONCLUSION

Infectious diseases including are still prevalent among migrants in Malaysia and these include tuberculosis, malaria, lymphatic filariasis, cholera, leprosy and leptospirosis. Intrinsic and extrinsic factors that significantly play a role in disease transmission in these high-risk migrant groups include their country of origin, vaccination status, working sectors, low educational background, impoverished living conditions, language barriers and financial constraints that impede access to health facilities and lacking awareness of disease transmission. This warrants the Malaysian government to focus on improving the welfare and health status of migrants by ensuring that they were provided with proper dwellings by their employers, introducing migrant-friendly health facilities and also reinforcing a comprehensive health insurance plan for migrant workers from all sectors, to limit the financial constraints faced by this vulnerable population.

Author contributions

Conceptualization: NS, ASA
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Formal analysis: NWSMP, NS, ASA
Funding acquisition: NS
Investigation: NWSMP, NS, ASA
Methodology: NS, ASA
Project administration: NS
Resources: NS, ASA

Software:
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Visualization: NWSMP, NS, ASA, SNMZ, HY, JWL
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Conflict of Interest
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