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

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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
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>
<thead>
<tr>
<th>Table 1. Inclusion and exclusion criteria for study selection</th>
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<tbody>
<tr>
<td>Inclusion Criteria</td>
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<tr>
<td>Primary and secondary data</td>
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<tr>
<td>Has migrants or non-Malaysians as subject of interests</td>
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<td>English or Malay publications</td>
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<td>Publication period; 1 January, 2016 to 31 December, 2020</td>
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**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,
<table>
<thead>
<tr>
<th>Disease / Infections agents</th>
<th>Outcomes / Key findings</th>
<th>Subjects</th>
<th>Study period</th>
<th>Study design / Study type</th>
<th>Study reference (author, year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vector-Borne &amp; Zoonotic Diseases</td>
<td>Two patients from a village Penampang, Sabah with Plasmodium falciparum malaria cases and 79 household members from 79 households of the village</td>
<td>Malaya</td>
<td>June – December 2012</td>
<td>Retrospective, case control study</td>
<td>Jeffrey et al., 2018</td>
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<td>The key factor for those malaria cases was living near stagnant water, which was exposed to the community via Anopheles balabacensis.</td>
<td>Malaya</td>
<td>2015-2017</td>
<td>Case series</td>
<td>MOH, 2016</td>
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<td>The outbreak was suspected to be caused by an Indonesian worker who got the infection from his hometown, Aceh.</td>
<td>Malaya</td>
<td>May – June 2020</td>
<td>Case series</td>
<td>Abdullah, 2020b</td>
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<td></td>
<td>The overall incidence rate of leptospirosis cases notified in 2012 and 2013 was 3.665 and 4.437 per 100,000, an increase of 13 cases (36.1%) compared to 36 cases in 2015.</td>
<td>Leptospirosis</td>
<td>2012-2013</td>
<td>Retrospective, cross-sectional study</td>
<td>Mohamed et al., 2020</td>
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<td></td>
<td>100 out of 350 were seropositive for leptospiral antibodies. The highest incidence rate in 2013 (55.34 per 100,000) was the highest recorded in this study.</td>
<td>Leptospirosis</td>
<td>June 2014</td>
<td>Prospective, cross-sectional study</td>
<td>Mohd Bidin et al., 2016</td>
</tr>
</tbody>
</table>

Table 2. Overview of the finalized, selected studies and articles (n=29)
<table>
<thead>
<tr>
<th>Vaccine-Preventable Diseases</th>
<th>Year</th>
<th>Study Type</th>
<th>Data Source</th>
<th>Findings</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>2014 - 2018</td>
<td>Retrospective, cross-sectional study analysis of online measles surveillance systems collected data</td>
<td>48 outbreaks involving 124 cases, in Petaling district</td>
<td>- 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%).</td>
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<tr>
<td>Influenzae B</td>
<td>August 2018 - May 2019</td>
<td>Prospective, cross-sectional study</td>
<td>436 healthy children aged 2-4 years from 30 registered childcare centres in Kuala Lumpur</td>
<td>- 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).</td>
<td></td>
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<tr>
<td>Human papillomavirus</td>
<td>Not stated</td>
<td>Cross-sectional questionnaire-based survey, a randomized controlled trial</td>
<td>320 randomly selected African immigrant women (ages 18-69) attending optional church services in Klang Valley, Malaysia</td>
<td>- 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%.</td>
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<tr>
<td>Tuberculosis</td>
<td>2017</td>
<td>Reported cases gathered by Ministry of Health, Malaysia</td>
<td>Total number of notified TB cases in 2017 including new cases, relapse cases, treatment after default cases and treatment after failure cases.</td>
<td>- 3,133 out of 26,168 TB cases in Malaysia were among non-Malaysian, which is higher than previous year (2,978 cases).</td>
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<tr>
<td>Tuberculosis</td>
<td>2014 - 2017</td>
<td>Retrospective, cross-sectional study analysis of data from the Malaysian TB Information System (TBIIS)</td>
<td>2,793 children in Kuala Lumpur, aged 0-14 years who were registered in the TBS from 2014 to 2017, with at least one household contact of TB cases</td>
<td>- 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 &lt; 5 years, positive TST and index-contact investigation period of &gt; 6 weeks were associated with TB disease (high risk group).</td>
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<tr>
<td>Tuberculosis</td>
<td>2013 - 2017</td>
<td>Retrospective, cross-sectional study data analysis from MyTB version 2.1</td>
<td>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)</td>
<td>- 479 TB cases (13.5%) were non-Malaysian where the highest proportion was from the Philippines (53.5%), 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.</td>
<td></td>
</tr>
<tr>
<td>Disease</td>
<td>Year</td>
<td>Study Design/Methodology</td>
<td>Key Findings/Notes</td>
<td>Reference(s)</td>
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<tr>
<td>Tuberculosis</td>
<td>May 2013</td>
<td>Prospective, cohort study</td>
<td>- No case of active TB detected among the 44 (9.1%) symptomatic participants.</td>
<td>Mohd Putera et al. (2023), Tropical Biomedicine 40(2): 138-151</td>
<td></td>
</tr>
</tbody>
</table>
|                         | 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 | - 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. | Maini et al., 2016; Masngut et al., 2020 |
| Tetanus                 | 2017-2018  | Reported cases gathered by Ministry of Health, Malaysia        | - 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-Malaysians citizens. | MOH, 2017, 2018 |
| Poliomyelitis           | 2020       | Cases update and confirmation by Director-General of Health, Malaysia | - 3 out of 4 confirmed polio cases were among non-Malay children.  
- All of them had never been vaccinated since birth. | Abdullah, 2020a |

**Food and Waterborne Diseases**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Year</th>
<th>Study Design/Methodology</th>
<th>Key Findings/Notes</th>
<th>Reference(s)</th>
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</thead>
</table>
| 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 | - 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 |
<table>
<thead>
<tr>
<th>Disease</th>
<th>Year</th>
<th>Study Type</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonellosis (Salmonella infections)</td>
<td>Not stated</td>
<td>Prospective, cohort study</td>
<td>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.</td>
<td>Mohd Putera et al. (2023), Tropical Biomedicine 40(2): 138-151</td>
</tr>
<tr>
<td>Cholera</td>
<td>2004 - 2014</td>
<td>Retrospective, cross-sectional study data analysis (data collected from MOH and Malaysian Metrological Department)</td>
<td>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 (&lt;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.</td>
<td>Woh et al., 2017</td>
</tr>
<tr>
<td>Cholera</td>
<td>2018</td>
<td>Reported cases gathered by Ministry of Health, Malaysia</td>
<td>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.</td>
<td>Hassan et al., 2020</td>
</tr>
<tr>
<td>Cholera</td>
<td>2018</td>
<td></td>
<td>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.</td>
<td>MOH, 2018</td>
</tr>
<tr>
<td>Parasitic Infections</td>
<td>September 2014 – August 2015</td>
<td>September 2014 – August 2015</td>
<td>Prospective, cross-sectional study</td>
<td>Prospective, cross-sectional study using microscopy, two types of ELISA and PCR</td>
</tr>
<tr>
<td>Protozoan infections</td>
<td>Study duration</td>
<td>Study Design</td>
<td>Study Population</td>
<td>Findings</td>
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<tr>
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<tr>
<td>Leishmaniasis</td>
<td>Not stated</td>
<td>Prospective, cross-sectional study</td>
<td>2,153 asymptomatic migrant workers working in the construction, manufacturing, farming, and agricultural sectors in selected areas in Peninsular Malaysia</td>
<td>- 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.</td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td>September 2014 – August 2015</td>
<td>Prospective, cross-sectional study</td>
<td>484 migrant workers from five working sectors; manufacturing, service, agriculture and plantation, construction, and domestic work</td>
<td>- The seroprevalence was 57.4%, and 53% had latent infection, indicative of previous exposure to <em>T. gondii</em>. - 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 <em>T. gondii</em> infection among them; age class (&gt; 45 years old) and migrant workers’ countries of origin (highest among Nepalese (77.8%), followed by Indonesian (58.3%) and Bangladesh (45.8%).</td>
</tr>
<tr>
<td>Blastocystis infection and subtypes</td>
<td>September 2014 – May 2015</td>
<td>Prospective, cohort study</td>
<td>220 migrant workers who had newly arrived and those who were already in the country for more than a year.</td>
<td>- <em>Blastocystis sp.</em> 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. - <em>Blastocystis</em> 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).</td>
</tr>
<tr>
<td>Giardiasis and cryptosporidiosis</td>
<td>September 2014 – August 2015</td>
<td>Prospective, cross-sectional study</td>
<td>388 migrant workers from five working sectors; construction, manufacturing, plantation, food service and domestic</td>
<td>- 10.8% were positive for <em>Giardia</em> spp. and 3.1% for <em>Cryptosporidium</em> 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.</td>
</tr>
</tbody>
</table>
| **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 (63.0%) 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 was unknown, 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 Aceh, 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 their medical 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 *Leptospirosis*. 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 Clastridium 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.

Polioymelitis
Polioymelitis 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 Wuchereria 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; Masgut 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
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