



## Review

# Vaccine-preventable diseases and immunisation coverage among migrants and non-migrants worldwide: A scoping review of published literature, 2006 to 2016



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## ABSTRACT

**Background:** Studies of vaccine-preventable disease (VPD) burden and immunisation coverage among migrants compared to locally-born populations present a mixed picture on whether migrants experience disproportionate VPD rates and immunisation inequities, and what the associated factors are. We conducted a scoping review to explore differences in VPD burden and immunisation coverage between migrants and non-migrants worldwide.

**Methods:** We followed Arksey and O'Malley's five stage scoping review method. We searched for empirical, peer-reviewed literature published in English that compared VPD burden and/or immunisation coverage between migrant and non-migrant groups published between 2006 and 2016 using MEDLINE, EMBASE, CINAHL, Sociological Abstracts, and Web of Science databases. Relevant information from the studies were charted in Microsoft Excel and results were summarised using a descriptive analytical method.

**Results:** Forty-five studies met the inclusion criteria (n = 13 reporting on VPD burden; n = 27 reporting on immunisation rates; n = 5 reporting on both). Studies that met the criteria only reported findings from high income countries or high-middle income countries. Accounting for results that were presented according to separate ethnic migrant sub-groups, almost all of the studies comparing VPD burden (n = 17, 89%) reported higher burden among migrants compared to non-migrants, while most studies measuring immunisation rates (n = 26, 70%) noted lower rates among migrants. Numerous factors contributed to these findings, including the influence of migrants' nativity, socio-economic status, migration background, generation status, residential duration, cultural/personal beliefs, language proficiency and healthcare utilisation.

**Conclusions:** Considerable variability of study foci and methodologies limited our ability to make definitive conclusions and comparisons, but the literature suggests that migrant populations generally experience higher VPD burden and lower immunisation rates. The findings highlight a number of important considerations for future research and immunisation programme planning. Future research should explore factors that influence VPD burden and immunisation rates, and strategies to overcome barriers to vaccine uptake among migrants.

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## 1. Introduction

International migration and displacement is increasing worldwide due to a complex set of factors, resulting in an unprecedented number of migrants and refugees that surpass global projections [25]. Recent estimates report that approximately 258 million international migrants worldwide are living outside their country of birth, with many relocating for work and study purposes [59]. Moreover, there are 22.5 million refugees forcibly displaced outside their country of origin due to fear of persecution [60]. The global phenomenon of migration has resulted in increasingly multicultural countries as migrants now comprise a substantial portion of the population in receiving high-income countries [59].

There are numerous health, economic, environmental and social implications of migration on host countries, particularly in terms of the transmission and management of infectious diseases, including vaccine-preventable diseases (VPDs) [20]. Recent outbreaks of VPDs have been linked to under-immunised migrant and refugee populations [31,64]. Post-arrival, migrants and refugees often face difficulties accessing and utilising healthcare, including preventive healthcare such as immunisations, due to a complex myriad of factors related to language, cultural competency and health beliefs to name a few [32,46,47,52,39,19]. Vaccinations are critical in protecting the health and wellbeing of migrants and refugees and reducing their risk of acquiring VPDs.

Previous studies exploring disparities of immunisation rates and burden of VPDs between migrants and host populations have presented a mixed picture on whether migrants are disproportionately impacted and what the associated factors are. Related literature tends to focus on a specific country [65], sub-set of migrants (e.g., travellers visiting friends and relatives) [23], methodology of included studies [58,65], region or [43] or disease [58,56]. A comprehensive review on this complex topic has yet to be done from a global perspective. As such, the purpose of this scoping review was to explore differences in VPD burden and immunisation coverage between migrants and non-migrants worldwide.

## 2. Methods

We conducted a scoping review using Arksey and O'Malley's five stage process (2005). To ensure rigor of the review, we undertook additional expert consultation to provide different perspectives throughout the process [2]. Experts provided feedback on the research question, search strategy, study selection criteria, and preliminary findings.

### 2.1. Stage 1 - Identify a research question

This scoping review aimed to explore differences in VPD burden and immunisation coverage between migrants and non-migrants

worldwide. The purpose was to summarise and disseminate relevant research findings and identify research gaps in existing literature to guide future research.

### 2.2. Stage 2 - Identify relevant studies to the research question

An experienced research librarian (JK), searched Ovid MEDLINE (1946-), Ovid EMBASE (1974-), CINAHL, Sociological Abstracts, and Web of Science Core Collection using combinations of keywords and controlled vocabulary terms where available (Supplementary file 1). To search for additional relevant literature, an author (NG) searched Google Scholar and reviewed the first 10 pages of results, hand-searched key journals and reviewed suggestions from expert consultation. Search terms included, but were not limited to, vaccinations, immunisations, immunizations, inoculations, immigrants, asylum seekers, determinants, communication, promotion, coverage, and uptake. When necessary, Medical Subject Headings were exploded to ensure the search was as comprehensive as possible. The initial searches were run on December 12, 2016 and limited to articles published from 2006 and onward. This timeframe enabled us to focus on more recent literature that reflect current vaccine practices compared to prior, more limited, availability of vaccines. All returned citations were exported into EndNote®.

For the purpose of this review, the terms “immigrant” and “migrant” were defined as individuals who were living outside their country of birth irrespective of the reason for migrating or legal status [24]. We included first-generation migrants (i.e., individuals who have moved to a new country) and second-generation migrants (i.e., children of first-generation migrants). Common VPDs and associated vaccines [67] were selected for this review, including: cholera, diphtheria, *Haemophilus influenzae* type b (Hib), hepatitis A (Hep A), hepatitis B (Hep B), human papillomavirus (HPV), influenza, measles, meningococcal disease, mumps, pertussis (whooping cough), pneumococcal disease, poliomyelitis (polio), rabies, rotavirus, rubella, tetanus, tuberculosis (TB), typhoid fever, varicella (chickenpox) and herpes (shingles) zoster, and yellow fever.

### 2.3. Stage 3 - Review and select studies for inclusion in the final review

Inclusion criteria for studies were: (i) empirical, peer-reviewed research; (ii) published in English; and (iii) compared VPD burden and/or immunisation coverage between migrant and non-migrant groups. Studies were excluded if they focused on non-vaccine preventable diseases, diseases acquired through travel, genetic descriptions, vaccine safety or vaccine efficacy. Studies were also excluded if the focus was on travellers visiting friends and relatives, rural-to-urban migrants, internally displaced people, seasonal workers, nomadic or gypsy populations, international adoptions or non-human samples.

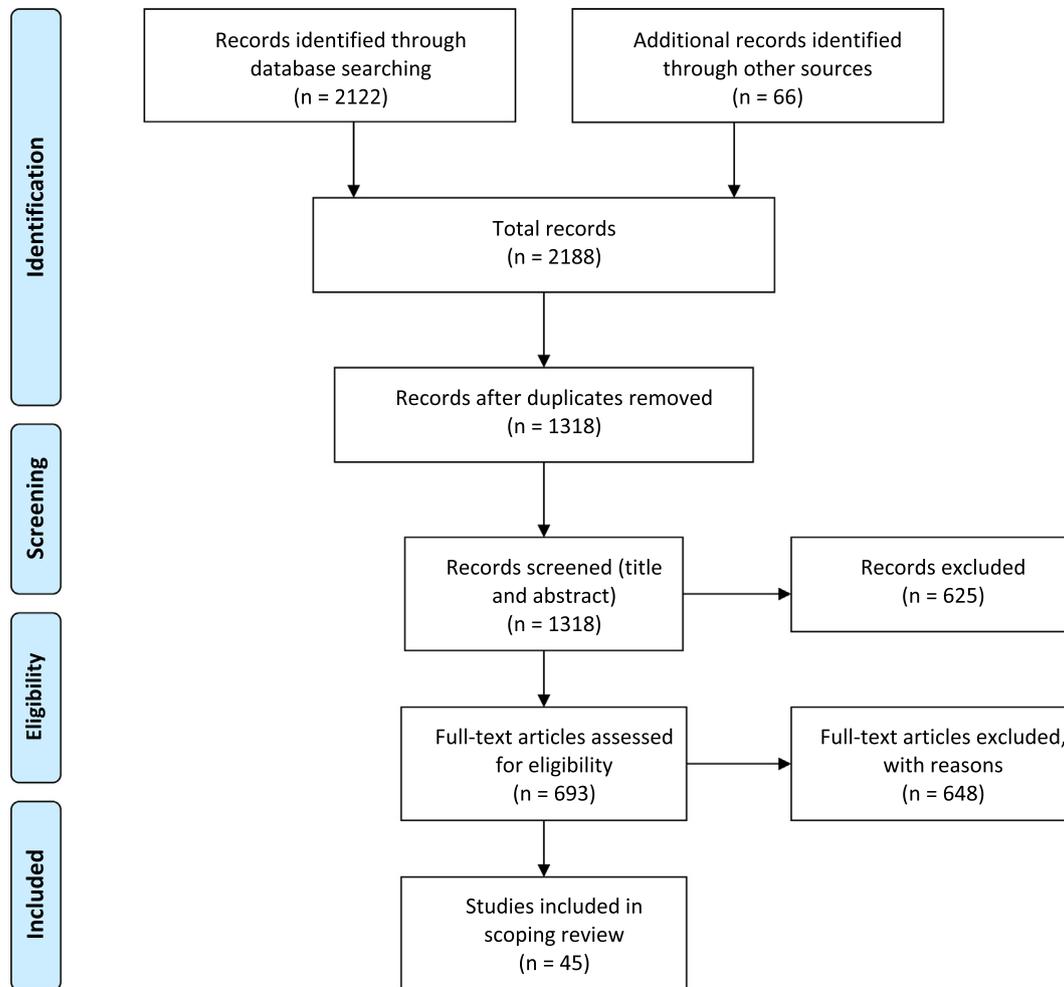


Fig. 1. PRISMA flowchart of study inclusion.

Two reviewers (NC, NG) independently conducted title and abstract screening and full-article review for inclusion/exclusion. The reviewers met at initial, midway and endpoints of the title/abstract screening to review disagreements and reach consensus [33]. Full articles were reviewed for relevance and the reviewers sought consensus on all disagreements for included articles.

#### 2.4. Stages 4 and 5 - Chart information from the selected studies and presenting the results

Information from the included studies were charted in Microsoft Excel using the following headings: author(s), publication name, publication year, title, study aim, VPD(s) and/or vaccine(s) of interest, study setting, study design, study sample, and key findings. The reviewers independently extracted data from the first 20 studies (44% of the included dataset) and then met to discuss a consistent approach for data extraction and charting [33]. Each reviewer then charted the remaining studies in batches and met on a weekly basis to ensure data extraction addressed the research aim. Results were summarised using a descriptive analytical method.

### 3. Results

The search identified 2122 studies, with an additional 66 studies included from hand searching and suggestions from expert consultation, resulting in a final set of 2188 studies, of which 45 met the inclusion criteria (Fig. 1). We reported VPD disease burden

measured by disease rates, disease susceptibility (due to naturally- or vaccine-acquired immunity) or seroprevalence rates between migrants and non-migrants. Studies that specifically looked at vaccine medical records, vaccine register data or self-reported vaccination coverage were assessed for differences in vaccination rates between migrants and non-migrants. Studies that stratified their results according to different ethnic migrant subgroups were kept separate where possible to make comparisons with the non-migrant population. For studies that adjusted for confounding factors, we reported the results of the final model where possible.

#### 3.1. Characteristics of included studies

Tables 1.1 and 1.2 provide an overview of the migrant population, host country and VPD or vaccine focus of each study. The studies were carried out across a wide range of geographical regions, yet all studies were conducted in high income countries or high-middle income countries that receive migrants and refugees. We found no studies in this search examining low-income countries. Twenty-five studies were carried out in the European region. Only one study looked at numerous European countries, while others were country-specific, including Spain (n = 6), Germany (n = 3), the Netherlands (n = 3), Italy (n = 3), Denmark (n = 3), the United Kingdom (n = 1), France (n = 1), Greece (n = 1), Switzerland (n = 1), Norway (n = 1), and Sweden (n = 1). Fifteen studies were carried out in North America, predominantly from the USA (n = 13) and only two from Canada. Lastly, a selection of

**Table 1.1**  
Migrant populations, countries and foci of studies that compared vaccine-preventable diseases between migrants and non-migrants.

Reference (migrant population, host country, VPD(s) of focus)	Rates in migrants compared to host populations <sup>a</sup>
Abraham et al., 2013 [1] (African migrants, USA, TB)	+
Cai et al., 2011 [6] (child migrants, Germany, hepatitis B)	+
Carnicer-Pont et al., 2008 [7] (female migrants, Spain, rubella)	+
Chu et al., 2013 [9] (migrants, Europe, hepatitis B)	+
Dominguez et al., 2007 [13] (female migrants, Spain, rubella)	+
Erkens et al., 2014 [14] (child migrants, Netherlands, TB)	+
Kyrka et al., 2009 [30] (child migrants, Greece, hepatitis A)	+
Levy et al., 2010 [34] (Latino and Asian male migrants, USA, hepatitis B)	–
	Latino
	Asian
Limina et al., 2015 [35] (migrants, Italy, TB and hepatitis B)	+
Lin et al., 2008 [36] (Southeast Asian female migrants, Taiwan, hepatitis B)	+
Liu et al., 2007 [37] (Asian female migrants, Taiwan, hepatitis B)	+
Ng et al., 2016 [48] (migrants and refugees, Canada, general)	+
Quang et al., 2010 [50] (Asian/Pacific Islander migrants, USA, hepatitis B)	x
Romanus, 2006 [54] (migrants, Sweden, TB)	+
Ruesen et al., 2014 [55] (migrants, Netherlands, TB)	+
Talukder et al., 2007 [57] (Bangladeshi female migrants, UK, varicella)	+
Vilajeliu et al., 2015 [62] (female migrants, Spain, rubella)	+
Whelan et al., 2012 [63] (migrants, Netherlands, hepatitis B)	+
	Total: 19 <sup>†</sup> (17+; 1–; 1x)

<sup>a</sup> + = migrants had higher rates compared to the host population; – = migrants had lower rates compared to the host population, x = no difference in rates between migrants and host population.

<sup>†</sup> Totals equal to more than the number of included articles to account for studies that presented results according to separate ethnic migrant sub-groups.

studies were carried out in Taiwan (n = 2), China (n = 1), Australia (n = 1), and Iran (n = 1). The migrant populations of focus were from various geographical regions. The included studies looked at migrant or refugee groups in general (n = 16), while 13 studies looked at migrant children or children of migrants, three looked at refugee children, three focused on male migrants and 10 on female migrants specifically. Some studies specifically focused on migrants from the following countries or regions: Africa, Hispanic/Latin countries, Asia Pacific, Bangladesh, Haiti, Mexico, Europe and Arab Nations. Studies' sample sizes varied from 70 individuals to whole-population level studies. Only two papers had sample sizes under 100, six were between 100 and 1000, 25 were between 1000 and 100,000, and 11 were above 100,000. The majority of studies were cross-sectional (n = 21) and cohort studies (n = 8). A range of other study designs were also used, including, but not limited to, retrospective chart reviews, surveys and literature reviews. Of the included studies, 13 addressed VPD burden, 27 addressed immunisation coverage and 5 studies addressed both.

### 3.2. Burden of vaccine-preventable diseases among migrants and non-migrants

While most studies focused on one VPD, some studies addressed several (Table 1.1). For the purpose of this analysis, VPDs have been counted individually and thus the total is higher than the included number of studies. The VPDs studied included hepatitis (n = 9), TB (n = 5), rubella (n = 3), varicella (n = 1), and general VPDs (n = 1).

Overall, the literature on VPD burden showed that migrants, and their children, experienced a higher burden compared to the local non-migrant population (n = 17; 89%) (Table 1.1). A number of factors were given in these studies to explain this finding (Table 2). Some factors included migrants being under-immunised (which will be discussed in more detail in the following section) [13,30,34], low socio-economic status [6,9,35], and poor living conditions thereby influencing disease rates [6,9,35]. Higher disease burden experienced by migrants was also influenced by their origin country and if it was characterised as having high disease endemicity [1,7,6,30,35,36,48]. Furthermore, VPD burden was exacerbated by migrants becoming infected when travelling to visit their country of origin [30,35,36,62].

A portion of the literature stratified findings based on parental immigration status. For example, one study explored the prevalence of hepatitis B among children who had a 2-sided migration background (i.e., single-parent migrant families or families with two migrant parents) compared to those with a 1-sided migration background (i.e., 1 migrant parent and one locally-born parent) [6]. This study found that VPD burden was higher amongst children in 2-sided migrant families, potentially due to higher disease exposure from family members [6]. Similarly, studies compared the effects of first and second generation status on VPD burden. These studies found that disease burden was higher among first generation migrants compared to second generation migrants, indicating that nativity has a strong influence [6,14,63]. Only one study found no difference in VPD burden between foreign-born students compared to those with foreign-born parents; however, the lack of significance was attributed to the study's small sample size, and the

**Table 1.2**

Migrant populations, countries and foci of studies that compared immunisation coverage between migrants and non-migrants.

Reference (migrant population, host country, vaccine(s) of focus)	Rates in migrants compared to host populations <sup>a</sup>
Astray-Mochales et al., 2016 [3] (migrants, Spain, influenza)	–
Budhwani & De, 2016 [4] (Asian migrants, USA, influenza)	–
Buelow & Van Hook, 2008 [5] (child migrants, USA, childhood)	–
Chung et al., 2016 [10] (North Korean child refugees, China, general)	–
Dallo & Kindratt, 2015a [11] (European and Arab male migrants, USA, influenza and pneumonia)	–
Dallo & Kindratt, 2015b [12] (European and Arab female migrants, USA, influenza and pneumonia)	–
Dominguez et al., 2007 [13] (female migrants, Spain, rubella)	–
Fabiani et al., 2016 [15] (migrants, Italy, influenza)	–
Fernandez de Casadevante et al. 2016 [17] (female migrants, Denmark, HPV)	–
Gelman et al., 2013 [18] (Hispanic female migrants, USA, HPV)	×
Guthmann et al., 2013 [21] (child migrants, France, BCG)	+
Guttmann et al., 2008 [22] (child migrants, Canada, childhood)	+
Jimenez-Garcia et al., 2008a [26] (migrants, Spain, influenza)	×
Jimenez-Garcia et al., 2008b [27] (migrants, Spain, influenza)	–
Joseph et al., 2012 [28] (Haitian female migrants, USA, HPV)	×
Karki et al., 2016 [29] (migrants, Australia, influenza)	–
Kyrka et al., 2009 [30] (child migrants, Greece, hepatitis A)	–
Levy et al., 2010 [34] (Latino and Asian male migrants, USA, hepatitis B)	–
	Latino
	Asian
Lu et al., 2014 [38] (migrants, USA, general)	–
Mendiola et al., 2016 [40] (Mexican migrants, USA, influenza)	–
Meynard et al., 2016 [41] (child migrants, Switzerland, childhood) <sup>§</sup>	–
Mikolajczyk et al., 2008 [42] (child migrants, Germany, childhood)	×
Moller et al., 2016 [44] (child refugees, Denmark, childhood)	–
Moller et al., 2018 [45] (female child refugees, Denmark, HPV)	–
Poethko-Muller et al., 2009 [49] (child migrants, Germany, measles)	–
Quang et al., 2010 [50] (Asian/Pacific Islander migrants, USA, hepatitis B)	×
Ricco et al., 2016 [51] (male migrants, Italy, tetanus)	–
Riise et al., 2015 [53] (child migrants, Norway, childhood)	–
Varan et al., 2017 [61] (child migrants, USA, childhood)	–
Vilajeliu et al., 2015 [62] (female migrants, Spain, rubella)	+
Wolf et al., 2016 [66] (child migrants, USA, general) <sup>‡</sup>	–
	Somalian
	Mexican
	Indian
	Russian
	Ukrainian
Zahraei et al., 2014 [68] (child migrants, Iran, general)	–
	Total: 37 <sup>(5+; 26–; 6×</sup>

<sup>a</sup> + = migrants had higher rates compared to the host population; – = migrants had lower rates compared to the host population, × = no difference in rates between migrants and host population.

<sup>†</sup> Totals equal to more than the number of included articles to account for studies that presented results according to separate ethnic migrant sub-groups.

<sup>‡</sup> Presented results refer to those of measles vaccination.

<sup>§</sup> Presented results refer to the immunisation status of the study population by years spent in the host country.

results indicated prevalence rates 3–11 fold higher among the migrant study population compared to the US population [50].

### 3.3. Immunisation coverage among migrants and non-migrants

Studies on immunisation coverage varied in methods used, and focused on single or multiple vaccines (Table 1.2). Each vaccine was counted individually, except for general childhood vaccines. The vaccines of focus were influenza (n = 9), childhood vaccines (n = 7), general vaccines (n = 4), HPV (n = 4), hepatitis (n = 3), pneumonia (n = 2), rubella (n = 2), tetanus (n = 1), Bacillus Calmette–Guérin (BCG) (n = 1), and measles (n = 1). The majority of studies (n = 26, 70%) found that migrants had lower immunisation rates than the host population. In contrast, five studies (14%) found that migrants had higher immunisation rates compared to the host population, while six studies (16%) found no difference (Table 1.2). Again, various factors were noted in these studies to explain these findings (Table 2).

Nativity influenced lower immunisation rates among migrants whether focusing on men or women and controlling for various potential confounding factors, including demographic, socio-

economic, health insurance and health care access, behavioral risk factors, and acculturation characteristics [4,10,11,12,40,38,49,61]. Studies also noted that nativity impacted timely vaccinations, as delayed vaccinations occurred more frequently among migrants compared to non-migrants [53,68].

Considering that childhood vaccination is ultimately a parental decision, some studies specifically discussed parental nativity in relation to vaccination uptake among their children [5,17]. Foreign-born migrants and female Danish second generation migrants with two foreign-born parents were less likely to initiate the free HPV vaccination programme compared to Danish women with one or two Denmark-born parent(s) [17]. Furthermore, among foreign-born immigrants, HPV programme initiation and vaccine coverage were higher among those who had lived in Denmark for longer periods of time indicating that residential duration also had an influence [17]. Residential duration also influenced timely immunisation, with findings showing recent migrant mothers (residents of 5 years or less) were the least likely in the country to vaccinate their children on time [5].

Many studies noted immunisation coverage rates varied depending on the country of origin of first generation migrants

**Table 2**

Summary of key factors identified from the included studies (n = 45) that influenced the burden of vaccine-preventable diseases and immunisation coverage among migrants.

---

Burden of vaccine-preventable diseases
– Immunisation status
– Health-care seeking behaviour
– Country of origin (and travelling to visit their country of origin)
– Nativity (first- versus second-generation migrants)
– Parental immigration status (1- versus 2-sided migration)
– Socio-economic status and living conditions
– Age
Immunisation coverage
– Nativity (first- versus second-generation migrants) and for children, parental nativity
– Country of origin
– Citizenship status
– Duration of residence in host country
– Language
– Perceptions of disease severity and susceptibility
– Cultural, religious and personal beliefs
– Age
– Employment
– Access and utilisation of healthcare services
– Health insurance coverage
– Socio-economic status

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and parents of second generation migrants, although no definitive conclusions could be made due to varying study findings [11,12,15,17,29,38,44,45,66]. Although, a large retrospective cohort study in the US noted that cultural/personal beliefs and perceptions of disease severity and susceptibility may underpin varying immunisation patterns by parental country of birth [66].

Only two studies specifically reported on the influence of language on vaccination coverage [29,38]. Reported vaccination coverage was lower among migrants who spoke a language other than English at home compared to English-speaking immigrants [29]. Language may present a barrier to accessing preventative services, such as immunisations, and communicating with healthcare workers [29]. Other factors, such as personal and religious beliefs, may influence lower immunisation coverage among migrants [51], along with younger age, being employed, and less utilisation of health services [15]. However, all of these factors are understudied. Future research should consider including these factors to increase our understandings of the complexities underlying vaccination coverage.

Six studies found no difference between vaccination rates of migrants compared to non-migrants [18,26,28,34,42,50]. Two of these studies showed significant differences before adjusting for sociodemographic and health care access covariates [18] or age and comorbidity confounders [26], while one found no difference but did not adjust for confounders [42]. Regardless, findings uncovered important differences in vaccine seeking behaviours between migrants and native-born adults. For instance, migrants received the influenza vaccine at their “own request” more frequently compared to native-born population (18.8% versus 9.4%) and less frequently because it was “recommended by a physician” (70.1% versus 85.5%) [26]. A study examining HPV vaccine receipt among daughters of US-born African-American and Haitian-born migrant women found no difference in immunisation coverage; this finding may be attributable to comparing the migrant group to another vulnerable ethnic group instead of comparing rates to the majority of locally-born mothers, which is the typical reference group [28]. Another study focusing on low income men reported that Asian migrants and US-born men had similar self-reported hepatitis B vaccination rates, although found lower rates among Latino migrants [34]. This study did not perform serologic testing for vaccine-associated immunity markers so the authors could not validate self-reported vaccination rates [34]. Finally, a study found no

difference in hepatitis B coverage rates between foreign-born students compared to those with foreign-born parents; however, this finding may be influenced by a lack of statistical power and by looking at self-reported coverage, which may be subject to recall bias [50].

Some studies found that migrant populations had higher vaccination rates compared to the native-born population [21,22,62,66]. These studies attributed high vaccination rates among migrant populations to healthcare policies including vaccination of families from endemic countries [21], universal vaccine provision [22], and screening/immunisation programmes targeting vulnerable populations [62].

#### 4. Discussion

The purpose of this scoping review was to summarise findings and identify gaps in existing literature to guide future research. Although our search accounted for studies published worldwide, our review only found 45 studies that compared disease and immunisation rates between migrant and non-migrant populations. It is clear that available data are still limited and future research is needed to allow for researchers and practitioners to build and use theory in VPD prevention and immunisation programming for migrants. Despite searching for literature worldwide, all of the included studies represented high- and middle-income countries that receive migrants. Future research should focus on low-income countries that have high migration rates per capita. It is also important that future research reflects the current migration context. For instance, given the current migrant and refugee crisis in the Middle East, future research should focus on countries where migrants are predominately originating from (e.g., Syria, Afghanistan, Iraq, etc.) and those experiencing a migrant influx (e.g., Greece, Turkey, Germany, etc.) [16]. Moreover, research should explore the impact of the Rohingya refugee population migrating to Bangladesh given the potential for infectious disease outbreaks [8]. Many studies included in our review noted that immunisation coverage rates varied depending on the migrants' country of origin. Although no definitive conclusions could be made, studies attributed this finding to varying cultural/personal beliefs [22,66] and English language proficiency [22]. Thus, it is important that future studies focus on migrants' countries of origin rather than regions to yield specific information on the impact of geographical origin. Most of the included studies focused on hepatitis disease rates and influenza vaccination rates; future research should focus on other diseases and vaccines to provide a broader understanding. Almost half of the included studies were cross-sectional in design, highlighting the limitation of the representativeness of these ‘snapshot in time’ results. Given the complex factors that impact disease and immunisation rates, future studies should explore the influence of migrants' health care access and utilisation behaviour and perceptions of diseases and vaccines.

The majority of studies identified through our scoping review found that migrants experienced higher VPD burden and lower immunisation rates compared to host populations. While the results from each study was helpful in isolation, it was difficult to draw firm conclusions and synthesise the results due to the various methodologies and methods employed to measure VPD burden and immunisation rates. Moreover, there was much variation in the terminology employed and how studies defined the term “migrant” or “immigrant”. As such, there is a need to: (1) identify gold standard methodologies to allow for standardisation of research on VPDs and immunisation rates; and (2) develop common terminology to improve our ability to compare and contrast findings from different studies in the future.

Studies discussed many factors influencing VPD burden and immunisation rate disparities, most noting the strong influence of nativity. Studies that stratified migrants offered important insights, particularly with understanding the influence of generation status (i.e., first- versus second-generation migrant), migration background (i.e., the impacts of having one versus two migrant parents) and residential duration. This highlights that migrants are a heterogeneous population and as such, it is important to disaggregate migrant data to better understand migrant health. With increasing international migration, future studies should compare disease and immunisation rates between migrants and non-migrants, and focus on identifying influencing factors.

In order to produce more definitive and nuanced understandings of migrant health, it is recommended that studies stratify migrants according to various characteristics where possible, including generation status, migration background, parental and child immigration status, and residential duration, as previously mentioned, along with citizenship status, language proficiency, ethnicity, country of origin, and visa category (inferring the type of migration). We suspect substantial and important differences based on migration group, for example economic migrants compared to refugees. However, studies in our review often did not clearly specify the visa type of their study populations. As discussed above, those studies that did categorize by visa type used inconsistent terminology, thereby limiting our ability to compare populations. The collection of more detailed data about migrant populations in the future will benefit our understandings of vaccination coverage.

Studies included in our review strongly emphasised the need to implement targeted policies and practices that address the local context and impacted migrant groups to reduce health disparities between migrant and non-migrant populations. Three studies found that targeted or universal immunisation programmes not only improved immunisation rates among migrant populations, but these rates surpassed those of the locally-born population [21,22,62]. This evidence, albeit from a small selection of studies, provides valuable guidance for the design and implementation of successful vaccination campaigns. These studies suggest that campaigns should focus on identifying and vaccinating migrants from countries with high disease endemicity [21] and those with high disease susceptibility [62]. A Canadian study highlighted the positive impact on the vaccination status of migrant children because of universal access to primary care services, including vaccinations [22]. Moreover, attributes of low immunisation rates in migrant populations, including nativity and residential duration, highlight that special attention is warranted for recent immigrants and children with two foreign-born parents [5,15,17,38,44,45].

In order to measure the impact of targeted screening and vaccination programmes, this review calls for more evaluation and reporting on interventions implemented to reduce VPD burden and improve vaccination rates among migrants. As such, those who are involved in improving migrant policy and programmes are encouraged to monitor, evaluate and publish findings from their efforts to guide decisions for the best use of available resources and improve wider population health benefits. Sharing these results will help the broader public health community to avoid pitfalls and oversights and optimise immunisation strategies while designing vaccination campaigns and policies.

#### 4.1. Limitations of our search strategy

Our scoping review did not include relevant studies published in languages other than English. In addition, our review may have overlooked important studies published before 2006. The present review only included empirical, peer-reviewed studies and may have ignored potentially helpful grey literature published by gov-

ernment agencies or private foundations. Future research should aim to fill these gaps, potentially with a systematic review to glean information about the quality of research in this field.

## 5. Conclusion

This article presents the findings of a scoping review of recent empirical evidence on the differences of VPD burden and immunisation rates between migrants and non-migrants worldwide. The breadth of migrant groups, host countries, diseases and vaccines examined and varied methodologies employed limited the ability to make direct comparisons. However, regardless of these differences, almost all of the studies came to the same conclusion suggesting that it is a phenomenon that migrants and their children are at a higher risk of contracting or communicating VPDs compared to locally born citizens. Also, most studies found that migrants experienced lower immunisation rates compared to non-migrants. The studies that showed higher vaccination rates among migrants could be attributed to targeted government sponsored screening and vaccination campaigns. The included studies suggested many possible attributions for VPD burden and immunisation rates among migrants; however, the varying methodologies used did not definitively show the causes. Thus, future research would benefit from using standardised methodologies and common terminology for migrants, and stratifying migrants according to characteristics. Future research should explore factors influencing VPD burden and immunisation rates among migrants and strategies to overcome barriers to vaccine uptake to guide future programme development.

## Conflict of interest

All authors declare they have no conflicts of interest.

## Author contributions

NC contributed to the original concept and design of the study, participated in study selection and reporting, and drafted the manuscript. NG contributed to study selection and reporting and manuscript drafts. JK provided technical expertise, developed the search strategy and conducted the literature search. SB provided guidance during study selection and reporting, and contributed to manuscript drafts. All authors read and approved the final manuscript, and attest that they meet the ICMJE criteria for authorship.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2019.04.001>.

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