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Risk of vaccine preventable diseases in UK migrants: A serosurvey and concordance analysis

Mayuri Gogoi [a,b,1], Christopher A. Martin [a,b,c,1], Paul W. Bird [a,d], Martin J. Wiselka [a,c], Judi Gardener [d], Kate Ellis [c], Valerie Renals [c], Adam J. Lewszuk [c], Sally Hargreaves [e], Manish Pareek [a,b,c,*]

[a] Department of Respiratory Sciences, University of Leicester, UK
[b] Development Centre for Population Health, University of Leicester, UK
[c] Department of Infection and HIV Medicine, University Hospitals of Leicester NHS Trust, Leicester, UK
[d] Department of Clinical Microbiology, University Hospitals of Leicester NHS Trust, Leicester, UK
[e] Migrant Health Research Group, Institute for Infection and Immunity, St George's, University of London, London, UK

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ABSTRACT

Background: Vaccine preventable diseases (VPDs) such as measles and rubella cause significant morbidity and mortality globally every year. The World Health Organization (WHO), reported vaccine coverage for both measles and rubella to be 71 % in 2019, indicating an immunity gap. Migrants in the EU/EEA may be at high risk of VPDs due to under-immunisation and poor living conditions. However, there are limited data on VPD seroprotection rates amongst migrants living in the United Kingdom (UK).

Methods: We conducted an exploratory cross-sectional serosurvey amongst a sample of adult migrants living in Leicester, UK to: (a) determine seroprotection rates for measles, varicella zoster, and rubella in this group; (b) identify risk factors associated with seronegativity and, (c) understand if self-reported vaccine or diseases history is an effective measure of seroprotection. Participants gave a blood sample and completed a questionnaire asking basic demographic details and vaccine and disease history for the three VPDs. We summarised the data using median and interquartile range (IQR) for non-parametric continuous variables and count and percentage for categorical variables. We used logistic regression to establish predictors of seroprotection against these diseases. We examined the reliability of self-reported vaccination/disease history for prediction of seroprotection through a concordance analysis.

Results: 149 migrants were included in the analysis. Seroprotection rates were: varicella zoster 98 %, rubella 92.6 % and measles 89.3 %. Increasing age was associated with seroprotection (OR 1.07 95 % CI 1.01–1.13 for each year increase in age). Migrants from Africa and the Middle East (aOR 15.16 95 % CI 1.31 - 175.06) and South/East Asia and Pacific regions (aOR 15.43 95 %CI 2.38 - 100.00) are significantly more likely to be seroprotected against measles as compared to migrants from Europe and Central Asia. The proportions of migrants unsure about their vaccination and disease history combined were 53.0 % for measles; 57.7 % for rubella; 43.0 % for varicella. There was no agreement between self-reported vaccination/disease history and serostatus.

Conclusion: Our findings suggest lower levels of seroprotection against measles in migrants living in Leicester, UK, with younger migrants and those from Europe and Central Asia more likely to lack seroprotection. A high proportion of surveyed migrants were unaware of their vaccination/disease history and self-reported vaccine/disease was a poor predictor of seroprotection against VPDs which is important for clinical decision-making regarding catch-up vaccination in this population. Our results, although derived from a small sample, suggest that there may be gaps in seroimmunity for certain VPDs in particular migrant populations. These findings should inform future qualitative studies investigating barriers to vaccine uptake in migrants and population-level seroprevalence studies aimed at determining individualised risk profiles based on demographic and migration factors.

* Corresponding author: Department of Respiratory Sciences, University of Leicester, UK.
E-mail address: manish.pareek@leicester.ac.uk (M. Pareek).
[1] Joint first authors

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1. Introduction

Globally, vaccine preventable disease (VPDs) such as measles and rubella cause significant morbidity and mortality every year. The World Health Organisation (WHO) estimated that in 2018, 9.7 million cases and more than 140,000 measles-related deaths occurred across the globe (WHO, 2020a). These diseases require high population immunity to prevent transmission and outbreak; however, global vaccine coverage is still sub-optimal with both measles and rubella vaccine coverage reported to be 71 % in 2019 (WHO, 2020a). Furthermore, there have been disruptions to national vaccination programmes in many countries due to the COVID-19 pandemic, resulting in millions of children missing out on crucial vaccine doses (Causey et al., 2021). In Europe, there has been a resurgence of measles after the pandemic with 3851 cases reported in the region between January-May 2023 (ECDC, 2023). This has jeopardised the targets set by WHO to eliminate measles and rubella in atleast five WHO regions by 2020, and the new Immunization Agenda 2030 (IA 2030) is now particularly focussed on improving surveillance of measles cases and augmenting coverage of the recommended two doses (WHO, 2020b). Data published by the United Kingdom Health Security Agency (UKHSA) in 2021 show that measles and rubella cases are on the decline in the UK in recent years, however the uptake of Measles, Mumps, Rubella (MMR) vaccine is still below the 95 % target (94.6 for first dose and 87.4 % for second dose) set by the national measles elimination strategy (UKHSA, 2022). This poses a risk, particularly from importation and transmission of the virus from other countries where measles is endemic (Saliba, 2018).

Even before the pandemic, sub-optimal levels of vaccine coverage among local populations in several European countries together with high levels of internal and external migration in the region had made the prevention of outbreaks of VPDs more challenging (WHO, 2019). Migrants in the EU/EEA may be at high risk of VPDs due to under-immunisation resulting from disruption of health systems, receipt of insufficient vaccine dosage in their countries of origin, limited access to catch-up vaccination services in host countries and/or vaccine hesitancy (WHO, 2019; Mipatrini et al., 2017; Hargreaves et al., 2018). The risk is also heightened in certain settings such as camps, reception or detention centres housing humanitarian migrants where overcrowding and unsanitary conditions have led to outbreaks of VPDs (Lam et al., 2015). A recent systematic review of VPD outbreaks involving migrants in Europe reported 47 distinct VPD outbreaks between 2010 and 2020, with measles being most common followed by varicella, hepatitis A, rubella, and mumps affecting both children and adults, although 82 % of varicella outbreaks were reported in adult migrants (Deal et al., 2021a). The 'under-immunisation' of migrant groups has been cited as a causative factor in these outbreaks occurring most frequently in temporary accommodations housing refugees and asylum seekers (Deal et al., 2021a). The problem is compounded by the absence of reliable vaccination records for many migrant groups, making estimation of the proportion of migrants who might be susceptible to VPDs difficult (Deal et al., 2022). Addressing this gap in seroprotection knowledge is critical in light of the COVID-19 pandemic, which has demonstrated the effectiveness of mass vaccination programs in curbing transmission of VPDs (Moghadas et al., 2021; Watson et al., 2022). Additionally, the pandemic also offers lessons in targeted interventions to build vaccine confidence among vulnerable groups, such as migrants, which can be capitalised to improve vaccination rates in groups evidenced to have low uptake or seroprotection (Deal et al., 2021b).

While vaccine coverage is an important indicator of population immunity, gaps in vaccination data of migrants, makes estimation of immunity difficult in this group. Several studies aimed at establishing VPD seroprotection rates have, therefore, been conducted in migrant populations living in EU/EEA countries to establish this. Jablonka et al's study conducted in a large refugee cohort in Germany found that overall IgG seropositivity was 88.5 % for measles, 77.9 % for rubella and 95.9 % for varicella (Jablonka et al., 2017). Another study conducted among asylum seekers in Germany reported measles seroprotection rates of 79.9 %, rubella 85.1 %, and varicella 87.5 % (Toikkanen et al., 2015). Hagstam et al. (2019) serosurvey involving asylum seekers and foreign-born women who had previously attended antenatal screening in Sweden found significant variation in measles seroprotection rates depending on geographic origin of migrants, with gaps most prevalent in immigrants from some European regions. Similarly, a study conducted among migrants (all ages) in Spain found seroprevalence for rubella, measles and mumps was < 95 % in the overall group (91 % rubella, 88 % measles, 83 % mumps) and lower rates were observed in migrants >20 years (compared with those ≤ 20 years) (Norman et al., 2021). Other serosurveys conducted in Luxembourg (Hübschen et al., 2012), Netherlands (Freidl et al., 2016) and Denmark (Hvass et al., 2020) demonstrate variable levels of seroprotection for different VPDs and among people of different ages and from different countries of origin. Seroprotection surveys among migrants in the UK are rare as national systems for collection of health data at the point of arrival is not as robust as in other European nations. However, a recent large-scale data linkage study conducted to identify factors associated with lower coverage of measles-containing vaccine among children and adults in Wales found strong association between not being vaccinated and being born outside the UK (Perry et al., 2023). Similarly, a couple of seroprevalence studies on rubella and varicella zoster conducted in the late-2000s among pregnant women in London found low immunity among foreign-born women for these diseases (Talukder et al., 2007; Hardelid et al., 2009). A recent study conducted by Deal et al. (2022), explored the immunisation coverage among refugees being resettled in the UK between 2018 and 2019, and found low levels of recorded immunisation for key VPDs such as polio and measles, particularly among adults and adolescents. Recent European Commission on Disease Prevention and Control (ECDC) (ECDC, 2018) and the United Kingdom Health Security Agency (UKHSA) (UKHSA, 2022) guidelines recommend catch-up vaccination for adult migrants with no or incomplete vaccination records. These include tetanus, diphtheria (Td/IPV), Meningitis ACWY (MenACWY) and, MMR overall and certain others like human papillomavirus (HPV), pneumococcal polysaccharide vaccine (PPV) and shingles to at-risk populations (UKHSA, 2022). While these guidelines make clinical decision-making easier, concerns have been raised about the possibility of over-vaccinating already protected individuals (Mipatrini et al., 2017). Along with poor evidence of immunisation records, there is also paucity of data relating to seroprotection rates among migrants (including but not limited to refugees and asylum seekers) living in the UK and whether predictors of susceptibility to VPDs in migrant populations exist. We, therefore, conducted a cross-sectional serosurvey in a non-representative adult migrant population living in Leicester, UK to establish seroprotection rates and predictors of seroprotection against measles, rubella and varicella zoster in this group. We also investigated the concordance of self-reported vaccination and disease history with serostatus to determine if self-reporting is a reliable method for establishing vaccination/seroprotection status.

2. Methods

We conducted an exploratory cross-sectional serosurvey with a non-representative adult migrant population in Leicester, UK to understand (a) the level of seroprotection against measles, rubella and varicella in this group, (b) the risk factors associated with seronegativity and, (c) if self-reported vaccine or diseases history is an effective measure of seroprotection. Leicester is a multi-cultural and ethnically diverse city; the latest census report states that more than 40 % of the city's population are born outside England (ONS, 2023).

The study was conducted between January and March 2020, before the pandemic restrictions had been announced. We included adult migrants ($\geq$16 years) who were born aboard and were residing in Leicester. Participants were selected using a convenience sampling technique

without restrictions on migration status or length of stay in the UK. Recruitment took place at three different community venues attended largely by migrants [Leicester City of Sanctuary walk-in centre (a charity which provides support to asylum seekers and refugees), Leicester College (an educational institution offering English for Speakers of Other Languages (ESOL), attended by migrants) and the St. Paul's Polish Roman Catholic Church] and also at the Department of Infection and HIV Medicine, University Hospitals Leicester NHS Trust. At the community venues, the research team (comprised of the Chief Investigator, a Research Assistant and two research nurses) visited on days and times as mutually agreed with the partner organisation. Staff at these organisations informed their service-users about the research and the team's visit beforehand. However, no prior requests were made to participants to bring along their vaccination records (if available) and vaccination and disease history collected in the questionnaires was self-reported from memory. We made this decision as we were conscious that previous research has highlighted that significant proportions of migrants may not carry vaccination cards, potential reasons for this being loss or destruction of paper records in the migration process (Giambi et al., 2019). On the day of the visit, the team held a session where they went through the Participation Information Sheet (PIS) with potential participants in a group setting and answered their queries. Participants recruited at the Hospital were individually approached by one of the research nurses from amongst patients who attended the Infection and HIV clinic or were being treated at the Ward for some other infection. Participation was voluntary and written informed consent was obtained prior to participation.

About 10 ml of blood (2 × 4.7 ml) were collected through venous sampling from each participant. All samples were transported on the day of collection to the microbiology laboratory at Leicester Royal Infirmary, where serum was extracted from the blood samples and stored at −20 °C until further processing. For laboratory testing and data analysis, unique sample identifiers were assigned to the clinical samples and the completed questionnaires. Measles and Varicella IgG were analysed using the Liaison XL assays, while the Rubella IgG was tested on the ADVIA Centaur XP according to the manufacturer's instructions.

Rubella IgG used a cut-off of 10IU/mL (Centaur Rubella G assay standardization is traceable to WHO 1st International standard for human anti-rubella immunoglobulin, RUBI-1–94), measles IgG used a cut-off value of 175 mIU/mL (WHO Third International Standard for Anti-Measles, NIBSC code: 97/648) and varicella IgG used a cut-off of 100mIU/mL as evidence of immunity. The sensitivities of the assays were 94.7 % for measles, 99.9 % for rubella, and 100 % for varicella and the specificities were 97.4 % for measles, 100 % for rubella, and 94.2 % for varicella according to manufacturer's report. For the purpose of this study, participants with negative or equivocal test results were considered as susceptible and, people with positive IgG antibody results as protected. Results of the blood tests were available within 7–10 days and communicated to participants by post and a copy of the letter was also mailed to their respective General Practitioners (GPs), if they had opted for it.

We also administered a short questionnaire in English to collect demographic information including age, sex, ethnicity, country of birth, year of UK arrival and immigration status (on arrival and current). We also collected information on self-reported disease or vaccination history for measles, rubella and varicella in the questionnaire. Participants filled the questionnaires themselves in the presence of the research team, who supported with explaining the questions if clarifications were sought by any participant. Missing data was present for 17 items in year of UK arrival and in these cases, we accessed the electronic health record and used the first contact with health services as a proxy measure.

We calculated basic frequencies to describe our sample and the seroprevalence rates for measles, rubella and varicella zoster which are further disaggregated by sex, region of origin and immigration status on arrival. We summarised the data using median and interquartile range (IQR) for non-parametric continuous variables and count and percentage for categorical variables. We used univariable and multivariable logistic regression to determine predictors of (1) seroprotection against at least one VPD and (2) seroprotection against measles and presented the outcomes as crude and adjusted odds ratios (ORs). Measles was selected as the other diseases had high seroprotection rates and analysis of factors predicting this outcome would be unreliable without increasing sample size. Cohen's kappa coefficient and positive and negative predictive values (PPV and NPV respectively) together with 95 % confidence intervals were computed to measure the agreement between self-reported vaccine and disease history and IgG result. For all analyses besides the descriptive analysis, participants answering "don't know" to questions about vaccine/disease history were coded as having answered "no". Analyses were conducted using Stata (StataCorp LP, Texas, USA, Version 15.1), p values < 0.05 were considered significant.

Ethical approval for the study was received from London - Fulham Research Ethics Committee (19/LO/1846).

3. Results

150 participants were recruited. One blood sample was discarded due to a labelling error and excluded from analysis resulting in a final cohort of 149 participants. Table 1 shows a description of the cohort. 101/149 (67.8 %) were female and median age was 38 (IQR 31 – 48). The majority (51 %) of participants were originally from Asian countries, and nearly 29 % were EEA nationals.

Overall seroprotection rates in the group were: varicella zoster 98 %, rubella 92.6 % and measles 89.3 % (Table 1). Seroprotection rates for measles were lower amongst migrants from Europe and Central Asia compared to those from Africa and the Middle East (73.7 % % vs 97.1 % [chi-square $p = 0.005$]) or South Asia, East Asia and the Pacific (73.7 % vs 93.4 % [chi-square $p = 0.003$]).

In unadjusted and adjusted analyses we found that migrants from Africa and the Middle East (aOR 15.16 95 %CI 1.31 - 175.06) and South Asia, East Asia and Pacific regions (aOR 15.43 95 %CI 2.38 - 100.00) were significantly more likely to have evidence of seroprotection against measles compared to those from Europe and Central Asia (Table 2). Older migrants were more likely to have seroprotection against all VPDs (OR 1.07 95 %CI 1.01 – 1.13 for each year increase in age).

Over two-thirds of the population (rubella 70.5 %, measles 69.1 %, varicella 67.1 %) were unsure of their vaccination status. Similar proportions were unsure whether they had any history of these diseases (rubella 66.4 %, measles 61.7 % and varicella 47.7 %). The proportions of migrants unsure about their vaccination and disease history combined were 53.0 % for measles; 57.7 % for rubella; 43.0 % for varicella. Concordance analysis show almost no agreement between a combined measure of vaccination and disease history with serostatus (K: measles −0.05, varicella 0.01, rubella 0.03) (Table 3). The same predictor had a PPV of 83.7 % for measles, 98.5 % for varicella and 94.3 % for rubella. NPV was less than 10 % for all diseases. A sensitivity analysis excluding those unsure of both their disease and vaccination status showed little change in significant findings.

4. Discussion

We undertook a cross sectional analysis which provides the first data on seroprotection against measles, rubella and varicella among adult migrants living in the UK. We found the majority of migrants to be unaware of their vaccination and disease history and that self-reported vaccine/disease status is a poor predictor of seroprotection. Levels of seroprotection for measles were below the herd immunity threshold (HIT) of 95 %−97 %, as estimated by Plans-Rubió (2020) under different circumstances. Older migrants were less likely to be susceptible to VPDs and susceptibility to measles was more likely in migrants from Europe and Central Asia (the majority of whom were from Eastern Europe).

Our results are in keeping with previous seroprotection studies conducted in other European countries. Hagstam et al. (2019) study of

Table 1
Description of cohort stratified by serology result.

	Total $n = 149$	Measles		Rubella		Varicella	
		IgG positive $n = 133$ (89.3 %)	IgG negative $n = 16$ (10.7 %)	IgG positive $n = 138$ (92.6 %)	IgG negative $n = 11$ (7.4 %)	IgG positive $n = 146$ (98.0 %)	IgG negative $n = 3$ (2 %)
Age, years (med IQR)	38 (31 – 48)	39 (32 – 49)	33.5 (22.5 – 39)	38 (31 – 48)	37 (26 – 43)	38.5 (31 – 48)	21 (20 – 33)
Sex, n (%)							
Male	48 (32.2 %)	46 (95.8 %)	2 (4.2 %)	44 (91.7 %)	4 (8.3 %)	47 (97.9 %)	1 (2.1 %)
Female	101 (67.8 %)	87 (86.1 %)	14 (13.9 %)	94 (93.1 %)	7 (6.9 %)	99 (98.0 %)	2 (2.0 %)
Region of origin, n (%)							
Europe & Central Asia	38 (25.5 %)	28 (73.7 %)	10 (26.3 %)	37 (97.4 %)	1 (2.6 %)	38 (100.0 %)	0 (0.0 %)
Africa & Middle East	35 (23.5 %)	34 (97.1 %)	1 (2.9 %)	33 (94.3 %)	2 (5.7 %)	35 (100.0 %)	0 (0.0 %)
South Asia, East Asia & Pacific	76 (51.0 %)	71 (93.4 %)	5 (6.6 %)	68 (89.5 %)	8 (10.5 %)	73 (96.1 %)	3 (4.0 %)
Immigration status on arrival, n (%)							
UK national	4 (2.7 %)	4 (100.0 %)	0 (0.0 %)	4 (100.0 %)	0 (0.0 %)	4 (100.0 %)	0 (0.0 %)
Indefinite or discretionary leave to remain	7 (4.7 %)	6 (85.7 %)	1 (14.3 %)	7 (100.0 %)	0 (0.0 %)	6 (85.7 %)	1 (14.3 %)
Study or work visa	7 (4.7 %)	7 (100.0 %)	0 (0.0 %)	5 (71.4 %)	2 (28.6 %)	7 (100.0 %)	0 (0.0 %)
Husband / wife sponsorship	38 (25.5 %)	36 (94.7 %)	2 (5.3 %)	35 (92.1 %)	3 (7.9 %)	37 (97.4 %)	1 (2.6 %)
EEA national – working / self-supporting / on welfare / studying	39 (79.6 %)	10 (20.4 %)	46 (93.9 %)	3 (6.1 %)	49 (100.0 %)	0 (0.0 %)	
Refugee / asylum seeker / humanitarian protection	49 (32.9 %)	15 (93.8 %)	1 (6.3 %)	16 (100.0 %)	0 (0.0 %)	16 (100 %)	0 (0.0 %)
Don't know / prefer not to say / other	16 (10.7 %)	26 (92.9 %)	2 (7.1 %)	25 (89.3 %)	3 (10.7 %)	27 (96.4 %)	1 (3.6 %)
	28 (18.8 %)						

Table 2
Unadjusted and adjusted analysis of factors associated with seroprotection against measles.

Variable	n seroprotected/total (%) 133/149 (89.3 %)	Unadjusted OR (95 % CI)	p value	Adjusted OR (95 % CI)	p value
Age	–	1.07 (1.01 – 1.13)	0.01	1.23 (1.09 – 1.38)	0.001
Sex					
Male	46 / 48 (95.8 %)	-	-	-	-
Female	87 / 101 (86.1 %)	0.27 (0.06 – 1.24)	0.09	0.23 (0.04 – 1.35)	0.10
Region of origin					
Europe & Central Asia	28 / 38 (73.7 %)	-	-	-	-
Africa & Middle East	34 / 35 (97.1 %)	12.14 (1.46 – 100.7)	0.02	15.16 (1.31 – 175.06)	0.03
South Asia, East Asia & Pacific	71 / 76 (93.4 %)	5.07 (1.59 – 16.16)	0.006	15.43 (2.38 – 100.00)	0.004
Years since arrival	–	1.01 (0.97 – 1.06)	0.63	0.91 (0.83 – 1.00)	0.06
Previous measles vaccination or infection					
No / Don't know	97 / 106 (91.5 %)	-	-	-	-
Yes	36 / 43 (83.7 %)	0.47 (0.17 – 1.38)	0.17	0.54 (0.12 – 2.54)	0.44
Migrant status					
Non-refugee / asylum seeker	118 / 133 (88.7 %)	-	-	-	-
Refugee / asylum seeker	15 / 16 (93.8 %)	1.91 (0.23 – 15.48)	0.55	2.42 (0.17 – 34.82)	0.52

newly arrived migrants in Netherlands found evidence of varying levels of seroprotection (44–97 %) for measles among immigrants for different geographic regions, with seroprotection gaps most prominent in migrants from some European regions such as the Baltic countries, and the former Yugoslavia. Jablonka and colleagues' study of a refugee cohort in Germany also reported seroprotection for rubella and measles to be lowest among refugees originating in the European Region, although the difference was not statistically significant (Jablonka et al., 2017).

We found that older migrants were more likely to have evidence of seroprotection against measles and against VPDs generally, which could suggest previous vaccination or previous disease. This finding was consistent across the unadjusted and adjusted analyses implying that the association is not a result of confounding by other variables (e.g. years since arrival) that were included in the multivariable models. This association has been reported in previous studies and has been attributed to the recent breakdown of health systems in war-torn countries like Syria which has resulted in under-immunisation of the younger population (Jablonka et al., 2016). A further explanation relates to the decreased persistence of vaccine induced seroprotection as compared to that induced by natural infection. Another large study, however, has found adolescents and adult refugees entering the UK as refugees through the resettlement scheme were more likely than children to be under-immunised for key routine VPDs. It may be that in certain migrant populations where younger migrants are more likely to have received vaccines and older migrants are more likely to have acquired infection that antibody levels have waned in the time since vaccination in the younger individuals (Anichini et al., 2020; Hvass et al., 2020). For measles we found that seroprotection was associated with region of origin, with those from Europe and Central Asia being less likely to have seroprotection than those from Africa and the Middle East or Asia and the Pacific. Lack of seroprotection among migrants from the European Region may be explained by vaccine hesitancy, and barriers to accessing vaccination systems in host countries, among certain groups in some countries (Crawshaw et al., 2022; Deal et al., 2023). For example, data

Table 3
Concordance of self-reported vaccination and infection history with serology results.

Measles		IgG Positive	IgG Negative	PPV % (95 % CI)	NPV % (95 % CI)	Cohen's kappa
Disease	Yes	13	5	72.2 % (46.5 – 90.3 %)	8.4 % (4.3 – 14.5 %)	−0.05
	No *	120	11			
Vaccine	Yes	27	6	81.8 % (64.5 – 93.0 %)	8.6 % (4.2 – 15.3 %)	−0.04
	No *	106	10			
Combined D/V†	Yes	36	7	83.7 % (69.3 % - 93.2 %)	8.5 % (4.0 – 15.5 %)	−0.05
	No *	97	9			

VZV		IgG Positive	IgG Negative	PPV % (95 %CI)	NPV % (95 % CI)	
Disease	Yes	54	1	98.2 % (90.3 – 100.0 %)	2.1 % (0.3 – 7.5 %)	0.00
	No *	92	2			
Vaccine	Yes	31	0	100.0 % (88.8 % - 100.0 %)	2.5 % (0.5 – 7.3 %)	0.01
	No *	115	3			
Combined D/V†	Yes	67	1	98.5 % (92.1 – 100.0 %)	2.5 % (0.3 – 8.6 %)	0.01
	No *	79	2			

Rubella		IgG Positive	IgG Negative	PPV % (95 %CI)	NPV % (95 % CI)	
Disease	Yes	14	1	93.3 % (68.1 – 99.8 %)	7.5 % (3.6 – 13.3 %)	0.00
	No *	124	10			
Vaccine	Yes	29	2	93.6 % (78.6 – 99.2 %)	7.6 % (3.6 – 14.0 %)	0.01
	No *	109	9			
Combined D/V†	Yes	33	2	94.3 % (80.8 – 99.3 %)	7.9 % (3.7 – 14.5 %)	0.03
	No *	105	9			

† Yes = those answering yes to history of vaccination OR disease, No = those answering no or don't know to history of vaccination AND disease.
* those answering no combined with those answering don't know. D/V = disease or vaccination. PPV = positive predictive value, NPV = negative predictive value.

from the National Institute of Public Health – National Institute of Hygiene in Poland indicated a four-fold rise in parents refusing to have their children vaccinated between 2011 and 2014 (Kraśnicka et al., 2018). Additionally, although our data found high levels of seroprotection for the tested VPDs among participants from Africa and Middle East, evidence generated by other studies suggest that seroprotection against certain infections such as HPV may be low among migrants from the African continent due to low vaccine uptake arising out of religious considerations (Crawshaw et al., 2022).

Whilst previous studies have assessed the value of self-reported vaccine history in predicting serology status for VPDs in health care workers, medical students and, military recruits (Kumakura et al., 2014; Trevisan et al., 2007), to our knowledge, we are the first to conduct this analysis in migrants. PPV was over 80 % for all VPDs in our study. This is largely due to the low number of "false positives" (those that reported a history of vaccination or disease but did not have serological evidence of either event). This in turn is due to the high seroprotection rate for all diseases, though the effect is most marked for varicella. Moreover, NPVs were very low indicating that self-reporting is not a reliable method for ascertaining seroprotection. A finding corroborated by Cohen's kappa coefficients, which show poor agreement between outcomes from serological testing and self-reported histories of vaccination and disease.

Specific policies offering follow-up vaccination to newly arrived refugees and asylum seekers from outside the EU/EEA are available in several EU/EEA countries (Giambi et al., 2019). Our findings support targeted catch-up vaccination to adult migrants, for example those coming from endemic regions/countries within Europe. Coverage could be enhanced by incentivising follow-up vaccination for primary care providers (Carter et al., 2022b). Additionally, targeted public health messaging aimed at particular groups may provide an effective method of improving vaccine coverage amongst those at high risk of VPDs. Further, larger studies examining serological protection in migrant groups are urgently required along with research to establish the cost-effectiveness of offering catch-up vaccination to all migrants versus first checking serology and offering vaccination to those without evidence of seroprotection. These surveys should be combined with qualitative studies on issues such as vaccine hesitancy which influence seroprotection rates. Attending to these problems is also critical in light of improving the uptake of the COVID-19 vaccine, which has been marked by vaccine hesitancy in certain ethnic and migrant groups (Robertson et al., 2021; Page et al., 2022).

Our study has limitations, including our small sample size which, when combined with the low numbers of migrants who were seronegative for measles from Africa and the Middle East and South Asia, East Asia and the Pacific, resulted in wide confidence intervals around the estimates for this variable in our regression analyses. Data are from a single area of the UK and therefore will not be representative of the UK as a whole or migrant populations as a whole. For the purposes of regression and concordance analyses we amalgamated those answering "no" and those answering "don't know" to questions concerning vaccine/disease history. Given that a large proportion of migrants were unsure of their vaccine/disease status, excluding these individuals would have significantly reduced the number of observations in each analysis. To ensure this did not have a substantial impact on our findings we conducted a sensitivity analysis excluding those who were unsure of their status.

5. Conclusion

In conclusion, this is one of the first empirical investigations on seroprevalence studies among migrants for certain VPDs in Leicester, UK. Levels of seroprotection for measles were low in the sampled migrants, with younger migrants from Europe and Central Asia having the lowest levels which may put them at risk of contracting measles. There was no agreement between self-reported vaccination and disease history and serostatus which is important for clinical decision-making regarding catch-up vaccination, particularly for adult migrants. These preliminary findings should inform further population-level seroprevalence studies among migrants for various VPDs, particularly in light of the recent diphtheria outbreaks among asylum seekers in closed settings in the UK as well as further qualitative studies on vaccine hesitancy (including assessing structural and personal barriers to vaccine uptake). Such work could be used to inform targeted approaches to offering catch-up vaccination, taking into account demographic risk profile.

Author contributions

MP conceived the idea for the study and secured funding. MP designed the methodology with input from SH, MG, CAM and MJW. MP, MG, MJW, KE, VR and AJL collected the data. JG processed the laboratory samples. CAM analysed the data. MG and CAM wrote the original draft of the manuscript. All authors contributed to study planning and management, and revision of the manuscript and were in agreement to submit it for publication.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: MP reports grants and personal fees from Gilead Sciences and personal fees from QIAGEN, outside the submitted work. MG, CAM, PWB, MJW, JG, KE, VR, AJL, and SH have no competing interest to declare.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmh.2024.100217.

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