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Uptake rates of influenza vaccination in over 65s in Denmark: a comparison between Danish-born and migrant populations, 2015–21

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Abstract

WHO's Immunization Agenda 2030 has placed renewed focus on life-course vaccination, including among migrants. Despite the availability of a seasonal vaccine, influenza remains a key contributor to winter excess mortality in Northern Europe, yet limited data on influenza vaccination uptake in migrants has been published. We analyzed Danish national registry data to determine influenza vaccine uptake across six flu seasons (2015/16–2020/21) among migrants (asylum-pathway and quota refugees, family reunified migrants) ≥65 years matched 1:6 on age and gender to Danish-born individuals. We used multivariate logistic regression models controlling for migrant status (immigration status, time in Denmark) and other sociodemographic variables (age, gender, nationality, urban/rural residence) to identify factors associated with influenza vaccination uptake. All analyses were done in R v4.2.1. Across all six seasons, overall flu vaccination uptake was 49.3% (Danish-born: 50.9%; migrant cohort: 39.4%). Migrants were less likely [odds ratio (OR): 0.66; 95% confidence interval (CI): 0.64–0.67] to receive an influenza vaccine across all seasons, with this gap widening from 2015/16 (OR: 0.78; 95% CI: 0.74–0.84) to the 2020/21 season (OR: 0.44; 95% CI: 0.42–0.46). Family-reunified migrants were less likely to receive an influenza vaccine across the study period than asylum-pathway and quota refugees and those from the Sub-Saharan Africa region had the lowest uptake in terms of area of origin. This large and unique dataset shows that migrant groups have lower uptake rates for influenza vaccination compared with Danish-born individuals, with the gap widening over time. Going forward, developing tailored interventions, co-developed in collaboration with communities themselves, will be key.

Introduction

There has been a dramatic rise in globalization and migration in the last two decades [1]. In Denmark, the majority of immigration is relatively recent, with the proportion of the Danish population made up of immigrants and their descendants having increased from 3.3% in 1985 to 16.3% in 2025 [2]. Some migrant groups (defined as individuals residing outside their country of birth or usual country of residence [3]) may be at risk of being under-vaccinated and at-risk of vaccine-preventable disease due to differing or disrupted vaccination schedules in their country of origin or low vaccine uptake in the host country [4, 5], particularly those with precarious immigration status, such as asylum seekers and refugees [6–8]. Outbreaks of vaccine-preventable disease such as measles, diphtheria, influenza, and varicella have been recently documented in migrant populations in Europe, with refugee status highlighted as a risk factor [6, 8]. Ensuring immunization coverage reaches established Herd Immunity Thresholds is essential to prevent outbreaks resulting in morbidity and loss of life.

In Europe, influenza remains one of the main contributing factors to winter excess mortality, particularly among older groups, with outbreaks commonplace despite the wide availability of a seasonal vaccine [9, 10]. In Denmark, the yearly influenza vaccine is free for those 65 or over and other risk groups during the autumn and winter season. Migrants officially resident in Denmark [and therefore having a civil person registration (CPR) number] are eligible for vaccinations, along with all other healthcare services, in the same way as Danish citizens. However, asylum seekers and undocumented migrants generally do not have a CPR number and are usually not eligible to receive state-run healthcare or vaccination [11]. Since 2011, the Danish Red Cross has been running independent healthcare centers for these groups in an attempt to fill this gap, with services including postarrival health checks and vaccination [11, 12].

Uptake levels of influenza vaccination in over 65s in Denmark has increased substantially since the COVID-19 pandemic, with coverage in the 2022/23 season exceeding 80% [13], up from around 50% in the seasons preceding the pandemic [14]. However, influenza vaccination coverage among the elderly in Denmark has previously been shown to be imbalanced, with a range of health and sociodemographic determinants impacting coverage. Data from the 2017/18 season shows that those living in urban areas were more likely to be vaccinated compared with those in rural areas in Denmark [15].

Although data has not previously been published from the Danish setting, in similar settings, such as the UK and Australia, influenza vaccine uptake has been found to be lower among ethnic minority or migrant groups than the general population [16, 17], resulting in a higher risk of influenza-related morbidity and mortality in these groups. Recent research from Denmark has also shown that migrants face significant communication and knowledge barriers to accessing healthcare, including vaccination services, with refugees and those with low education found to be particularly at risk of access barriers [18].

While limited disaggregated data exists around influenza vaccine uptake by migration status, much can be learnt from the significant amount of data that was gathered during the pandemic. Although the COVID-19 pandemic and associated vaccine rollouts were an exceptional situation, many of the findings may still hold relevance to routine seasonal vaccination campaigns, such as influenza. A significant body of evidence suggests that the often relatively low uptake of COVID-19 vaccination among migrant groups was in many cases influenced by low institutional trust, legal/administrative barriers (perceived and real), direct or indirect financial barriers, increased circulation of misinformation, a lack of tailored, accessible information campaigns and structural injustices [6, 19–23], with heterogeneity between highly intersectional migrant groups important to recognize. There have since been significant concerns around the impact of COVID-19 vaccine hesitancy and misinformation on uptake of other vaccinations [24]. However, prior to this study, very little evidence has been published on any changes in localised patterns of routine vaccination uptake around the COVID-19 pandemic.

This study aimed to identify at-risk groups in terms of lower uptake of influenza vaccination, specifically examining differences between and within migrant and Danish-born cohorts using national registry data from the Danish Vaccine Register. It will also investigate changes in uptake patterns following the COVID-19 pandemic and COVID-19 vaccine rollouts. This will facilitate the identification of population groups in need of tailored strategies to improve influenza vaccine uptake rates in Denmark and other similar migrant-receiving countries.

Methods

Data source

We utilized data from the Danish Migrant Cohort, a nationwide register-based cohort of migrants (refugees and family-reunified migrants) obtaining a residence permit in Denmark between 1 January 1993 and 31 December 2015. All Danish-born individuals are assigned a unique CPR number at birth, whereas migrants are registered in the CPR-registry at date of receiving residency. The CPR can be used to track individuals through public registries at an individual level. Those without a CPR number (e.g. undocumented migrants, asylum seekers prior to receiving refugee status) could not be included, as inclusion in national registry data requires a CPR number.

Using each individual's CPR, we linked the cohort to data on influenza vaccination uptake (September 2015 to March 2021) originating from the Danish Vaccine Register at the Statens Serum Institute. The Danish Vaccine Register contains data on all vaccinations given in Denmark since June 2015.

Study population

The reference cohort for this study consisted of 147 151 adult migrants matched to a Danish-born comparison group (with Danish-born parents, those with one or more non-Danish parents were excluded). The Danish-born cohort was matched to the migrant cohort in a 1:6 ratio by age and sex. In total, 882 906 Danish-born were included in the comparison group.

Based on the reference cohort, we constructed annual cohorts (1st September–31st August) of individuals ≥65 years old for influenza seasons 2015/16–2020/21. Updated data from the national Civil Registration System (2015–21) was made available on persons in the cohort who had emigrated (surrendered their residence permit or submitted notification of emigrating) or died in this time period. Inclusion in a given annual cohort required a patient to have been aged 65 or over and included in the reference cohort for the entirety of the specified year. Therefore, the cohort for each consecutive season reflects both an addition of individuals who have aged to meet the '≥65 years' criteria and the removal of individuals who died or emigrated from Denmark. To investigate overall patterns in uptake rates across all six seasons, a 'combined' cohort was created, which included a distinct data point for each individual for every season that they met the inclusion criteria.

Data cleaning and analysis

Data cleaning and analyses were carried out using R version v4.2.1. The migrant cohort were grouped according to country and region of birth and their legal grounds of residence in Denmark, defined as migrant status: (i) Asylum-pathway refugees (granted refugee status after seeking asylum), (ii) Quota refugees (resettled in Denmark following an agreement with the United Nations High Commissioner for Refugees or a similar international organization [25]), and (iii) Family-reunified to either Danish/Nordic citizens, immigrants, or refugees. The migrant cohort were grouped into six groups according to region of origin, based on [26]: Eastern Europe and Central Asia; Europe, North America, and Oceania ('Western'); Middle East and North Africa; Latin America and the Caribbean; South and South-East Asia and Pacific (SSEA and Pacific); and Sub-Saharan Africa (countries included in each region are listed in Table S2). Municipality of residence in 2015 was used to group individuals by urban/rural residence: (i) City (Municipality >1000 residents/km^2), (ii) Suburban (>100 residents/km^2), and (iii) Rural (≤100 residents/km^2). Where residence data was not available from the 2015 season, residence data from 2014 was taken, or if not available, individual was put into the 'unknown residence' category.

Influenza uptake was calculated in different subcohorts of the study population by taking the number of individuals receiving at least one influenza vaccine in the relevant season, divided by the number of individuals meeting the criteria for inclusion in the cohort in the same season.

Two multivariate logistic regression models were run in order to identify populations with low uptake of influenza vaccination. The first model was run on the overall cohort (Danish-born and migrant cohorts combined), stratified by key sociodemographic variables (age, gender, urban/rural residence). The second multivariate logistic regression was run on the migrant cohort, stratified by migrant status (migrant status, time since migration, area of origin) as well as other sociodemographic variables (age, gender, urban/rural residence). All tests were two-tailed.

The 'combined' cohort was used to calculate an overall uptake rate across the six seasons, and multivariate logistic regressions run to identify factors influencing uptake across seasons. Uptake rates from the combined cohort were used to calculate and map differences in uptake by (i) district of residence in Denmark; and (ii) country of origin. Mapping analyses were done using ggplot2 and plotDK packages in R v4.2.1.

Results

Cohort demographics

Cohort demographics across the six flu seasons (2015–21) are described in Table S1. The cohort was largest in the final flu season (2020/21) with a total of 65 532 individuals over the age of 65 included, of whom 56 612 (86.4%) were Danish-born and 8920 (13.6%) were migrants.

In general, the demographics of the cohort remained similar throughout the six seasons. Females were slightly overrepresented

in both the migrant and Danish-born cohorts, making up between 53.9%–55.3% of included individuals. The 65–70 age group was the most represented in both the migrant and Danish-born cohorts. Around half (48.4%–49.0%) of individuals lived in suburban settings, with the migrant cohort more likely live in cities than Danish-born. Among the migrant cohort, the majority were asylum-pathway refugees (59.4%–61.3%), followed by family-reunified migrants (33.8%–35%). The most common area of origin was Central Asia and Eastern Europe (39.3–40.1), followed by the Middle East and North Africa (25.2–26.2) and Southeast Asia and Pacific (15.5%–16.1%) regions.

Overview of flu vaccination uptake across six seasons

When data from across the six seasons was merged, the overall flu vaccination uptake was 49.3%, with the overall uptake among Danish-born being 50.9% and migrant uptake 39.4%. Figure 1 shows the trend in uptake over time. Between the 2015/16 and 2021/22 seasons, uptake of flu vaccination increased in both the Danish-born and migrant cohorts. Migrants had consistently lower uptake in all seasons, with the gap in uptake between the Danish-born and migrant cohorts widening from 6.9% in the 2015/16 season to 21.1% in 2020/21.

Factors associated with vaccination uptake from 2015 to 2021

When data from all six flu seasons was combined, the migrant cohort were less likely than the Danish-born cohort to receive a flu vaccination [odds ratio (OR): 0.66; 95% confidence interval (CI): 0.64–0.67]. This association held across all individual seasons, further described in Table 1. From 2015/16 to 2018/19, the relationship between uptake in the Danish-born and migrant cohorts remained stable, with ORs between 0.73 (0.69–0.77) and 0.78 (0.74–0.84). The gap between Danish-born and migrant uptake widened in the in the 2019/20 and 2020/21 seasons, with migrants around half as likely (OR: 0.44; 0.42–0.46) as Danish-born to receive a flu vaccination by the 2020/21 season.

In all six flu seasons, there was a strong association between age and flu vaccination uptake across the whole cohort, with older age associated with higher uptake. Those over 80 years old were up to three times as likely (2016/17 OR: 2.84; 95% CI: 2.68–3.00) and those aged 71–80 years up to two times as likely (2015/16 OR: 2.03; 95% CI: 1.94–2.12) to receive a flu vaccination than those aged 65–70 years.

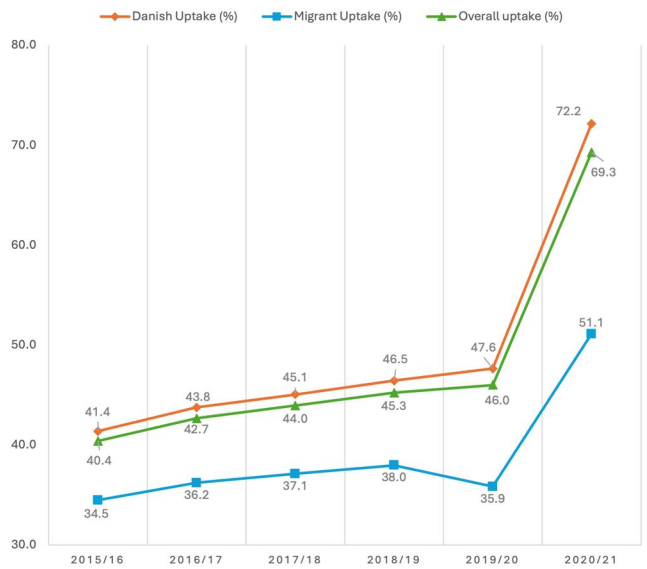

Figure 1. Uptake of flu vaccination over time (2015–21) among the Danish-born and migrant cohorts.

In terms of urban/rural residence, from 2015/16 to 2018/19, across the cohort those living in cities had higher uptake and were more likely than those living in suburban areas to receive flu vaccination (see Table 2 for ORs). This association changed direction by 2020/21, with those living in cities becoming less likely by the 2020/21 season than those in suburban areas (OR: 0.86; 95% CI: 0.81–0.9) to receive a flu vaccine. Across all six seasons, those living in rural areas and with unknown residence were less likely to receive a flu vaccine compared to those in suburban areas.

Factors associated with uptake in the migrant cohort

Within the migrant cohort, a number of factors were associated with uptake of flu vaccination, described in Table 2.

When migrant status was considered, uptake among quota and asylum-pathway refugees was higher than among family reunified migrants in all six seasons, with family reunified migrants less likely to receive a flu vaccine than asylum-pathway refugees. In terms of area of origin, uptake was consistently highest among those originating from the SSEA and Pacific region. Except those who were Stateless, individuals from Sub-Saharan Africa had the lowest uptake across all six seasons. Although patterns of flu vaccination by area of origin existed, there was a wide variation by country within areas of origin, shown in Figure S1. For example, within the Sub-Saharan Africa region, individuals originating from South Africa and Tanzania had relatively higher uptake of flu vaccination (54.2% and 47.1%, respectively), compared to the average across the region (24.8% when data combined across all six seasons).

As in the overall cohort, there was an association between age and flu vaccination uptake, with those in the older age groups more likely to receive a vaccine. This pattern held across all seasons in the migrant cohort, with the exception of 2020/21. In terms of rural/urban residence, uptake rates among migrants were highest among those who lived in suburban areas. Across all seasons, those living in rural areas or with unknown residence were less likely to receive a flu vaccine than those living in suburban areas. Among those living in cities, uptake was lower across all seasons compared to those living in suburban areas. By the 2020/21 season, migrants living in cities had the lowest uptake of flu vaccination (excluding the small group with unknown residence). In the Danish-born cohort, there was a pattern of higher uptake among those residing in the Capital region, shown in Fig. 2. In the migrant cohort, uptake by municipality showed no clear pattern.

Before the onset of the COVID-19 pandemic (2015/16–2018/19 seasons), uptake was higher among those who had lived longer in Denmark compared with those who had more recently arrived (less than 10 years in Denmark). However, in the 2019/20 and 2020/21 seasons, this pattern was reversed, with those who had more recently arrived having a higher uptake of flu vaccination compared with those who had lived over 10 years in Denmark.

Discussion

This study compared uptake rates of influenza vaccination among a cohort of Danish-born and migrant (refugees and family-reunified) individuals over the age of 65 in Denmark, across six influenza seasons (2015/16–2020/21). Influenza uptake rates among family-reunified migrants and refugees over 65 years old in Denmark were lower than among Danish-born (OR: 0.66; 95% CI: 0.64–0.67), with family-reunified migrants and those originating from Sub-Saharan Africa particularly at risk. While uptake in both migrant and Danish-born cohorts increased over the six seasons, especially following the COVID-19 pandemic, the gap between uptake in the Danish-born and migrant populations widened over time (2015/16 OR: 0.78; 95% CI: 0.74–0.84 and 2019/20 OR: 0.44; 95% CI: 0.42–0.46), highlighting that inequities in vaccination are

Table 1. Factors associated with uptake in the overall cohort (Danish-born and migrants combined) 2015/16–2020/21

	2015/16		2016/17		2017/18		2018/19		2019/20		2020/21	
	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)
Migrant status												
Danish-born	41.4	Ref	43.8	Ref	45.1	Ref	46.5	Ref	47.6	Ref	72.2	Ref
Migrant	34.5	0.78 (0.74–0.84)	36.2	0.75 (0.71–0.80)	37.1	0.74 (0.70–0.78)	38.0	0.73 (0.69–0.77)	35.9	0.64 (0.61–0.67)	51.1	0.44 (0.42–0.46)
Gender												
Male	39.5	Ref	41.6	Ref	42.8	Ref	44.3	Ref	45.2	Ref	68.5	Ref
Female	41.2	0.98 (0.94–1.02)	43.6	0.99 (0.95–1.03)	44.9	0.99 (0.95–1.03)	46.1	0.99 (0.96–1.03)	46.7	1.01 (0.97–1.04)	70.0	1.05 (1.02–1.09)
Age at start of flu season												
65–70	30.6	Ref	32.8	Ref	34.8	Ref	37.0	Ref	39.7	Ref	67.2	Ref
71–80	46.9	2.03 (1.94–2.12)	49.5	2.02 (1.94–2.11)	50.4	1.93 (1.85–2.01)	51.3	1.8 (1.73–1.87)	51.3	1.61 (1.56–1.67)	72.6	1.3 (1.26–1.36)
>80	53.2	2.73 (2.57–2.89)	56.6	2.84 (2.68–3.00)	57.7	2.72 (2.58–2.87)	58.4	2.54 (2.41–2.67)	55.7	2.03 (1.93–2.13)	69.1	1.19 (1.13–1.25)
Rural/urban residence												
Suburban	41.8	Ref	44.4	Ref	46.1	Ref	47.6	Ref	48.1	Ref	72.1	Ref
City	44.2	1.11 (1.04–1.17)	47.0	1.13 (1.07–1.19)	47.8	1.09 (1.04–1.15)	48.3	1.06 (1.00–1.11)	47.5	1.01 (0.96–1.06)	67.5	0.86 (0.81–0.90)
Rural	38.7	0.86 (0.83–0.90)	40.3	0.83 (0.80–0.87)	41.1	0.80 (0.77–084)	42.5	0.81 (0.78–0.84)	44.2	0.84 (0.81–0.87)	68.8	0.81 (0.78–0.85)
Unknown	2.1	0.03 (0.02–0.05)	3.2	0.04 (0.03–0.06)	4.6	0.05 (0.04–0.08)	4.9	0.06 (0.04–0.08)	5.2	0.06 (0.05–0.09)	7.8	0.04 (0.04–0.04)

Table 2. Factors associated with uptake in the migrant cohort, 2015/16–2020/21.

	2015/16		2016/17		2017/18		2018/19		2019/20		2020/21	
	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)	Uptake (%)	aOR (95% CI)
Gender												
Male	36.7	Ref	37.9	Ref	38.2	Ref	39.6	Ref	37.5	Ref	53.5	Ref
Female	32.8	0.86 (0.77–0.96)	34.9	0.90 (0.81–1.00)	36.3	0.94 (0.85–1.04)	36.7	0.91 (0.82–1.00)	34.5	0.91 (0.83–1.01)	49.1	0.87 (0.80–0.96)
Age at start of flu season												
65–70	30.8	Ref	31.9	Ref	32.9	Ref	34.3	Ref	33.4	Ref	51.7	Ref
71–80	38.7	1.5 (1.32–1.7)	41.5	1.57 (1.40–1.77)	42.5	1.55 (1.39–1.74)	43.2	1.51 (1.35–1.68)	40.4	1.38 (1.24–1.53)	55.2	1.16 (1.05–1.28)
>80	34.4	1.53 (1.30–1.80)	37.1	1.62 (1.39–1.88)	37.4	1.53 (1.32–1.76)	38.0	1.49 (1.30–1.71)	34.0	1.29 (1.12–1.47)	41.8	0.86 (0.76–0.97)
Rural/urban residence												
Suburban	38.7	Ref	40.7	Ref	41.5	Ref	42.3	Ref	40.6	Ref	56.4	Ref
City	36.8	0.95 (0.83–1.09)	38.3	0.95 (0.84–1.09)	39.1	0.95 (0.84–1.08)	39.7	0.94 (0.83–1.06)	35.5	0.85 (0.76–0.95)	50.9	0.83 (0.75–0.92)
Rural	33.5	0.82 (0.70–0.95)	34.9	0.81 (0.70–0.93)	35.7	0.81 (0.71–0.93)	37.2	0.85 (0.75–0.96)	35.3	0.80 (0.71–0.91)	52.7	0.87 (0.77–0.97)
Unknown	2.1	0.04 (0.02–0.07)	3.5	0.05 (0.03–0.09)	5.3	0.08 (0.05–0.12)	5.1	0.08 (0.05–0.11)	5.5	0.09 (0.06–0.13)	8.1	0.08 (0.06–0.10)
Migrant status												
Asylum-pathway refugee	38.4	Ref	39.8	Ref	40.3	Ref	42.1	Ref	59.5	Ref	54.5	Ref
Family reunified	27.2	0.64 (0.55–0.74)	29.4	0.59 (0.51–0.69)	35.1	0.63 (0.55–0.72)	32.5	0.67 (0.58–0.76)	50.0	0.67 (0.59–0.77)	44.6	0.69 (0.61–0.77)
Quota refugee	36.7	0.98 (0.74–1.29)	38.6	0.90 (0.69–1.18)	44.4	1.13 (0.89–1.44)	46.3	0.88 (0.69–1.11)	61.6	1.02 (0.82–1.27)	56.4	0.92 (0.75—1.14)
Area of origin												
Central Asia and Eastern Europe	36.8	Ref	37.0	Ref	37.3	Ref	38.0	Ref	36.7	Ref	50.8	Ref
Latin America and Caribbean	26.0	1.05 (0.54–2.05)	30.2	1.26 (0.71–2.24)	34.9	1.19 (0.69–2.02)	28.6	1.04 (0.64–1.69)	28.7	1.05 (0.67–1.64)	46.6	1.31 (0.88–01.94)
Middle East and North Africa	34.6	1.07 (0.92–1.24)	37.7	1.16 (0.99–1.35)	41.0	1.14 (0.98–1.32)	39.6	1.18 (1.03–1.36)	35.1	1.97 (0.85–1.11)	51.9	1.21 (1.07–1.37)
Southeast Asia and Pacific	42.0	1.60 (1.33–1.91)	44.4	1.71 (1.43–2.05)	50.2	1.7 (1.43–2.02)	47.6	1.85 (1.57–2.17)	46.0	1.71 (1.47–2.00)	64.2	2.32 (2.00–2.69)
Sub-Saharan	19.4	0.50 (0.38–0.65)	21.0	0.48 (0.37–0.62)	27.3	0.66 (0.52–0.84)	23.6	0.6 (0.48–0.76)	23.4	0.61 (0.49–0.77)	31.4	0.58 (0.48–0.71)
Western	26.4	1.04 (0.81–1.33)	32.7	1.28 (1.01–1.62)	32.6	1.14 (0.92–1.43)	30.9	1.14 (0.92–1.4)	28.4	1.02 (0.83–1.24)	44.0	1.15 (0.96–1.37)
Stateless	6.7	0.14 (0.03–0.61)	16.7	0.38 (0.14–1.04)	22.6	0.39 (0.16–0.94)	21.4	0.47 (0.22–1.03)	67.4	0.5 (0.25–1.01)	52.3	0.92 (0.48–1.75)
Time in Denmark												
0–10 years	28.2	Ref	30.0	Ref	32.6	Ref	34.2	Ref	34.7	Ref	51.1	Ref
11–20 years	34.7	1.16 (0.94–1.43)	37.2	1.27 (1.04–1.57)	38.1	1.17 (0.95–1.43)	39.3	1.09 (0.89–1.35)	37.2	0.94 (0.76–1.16)	50.2	0.76 (0.61–0.95)
>20 years	37.3	1.27 (1.00–1.61)	36.6	1.15 (0.92–1.43)	37.2	1.07 (0.86–1.32)	37.7	1.02 (0.83–1.26)	35.4	0.84 (0.68–1.04)	51.4	0.83 (0.67–1.02)

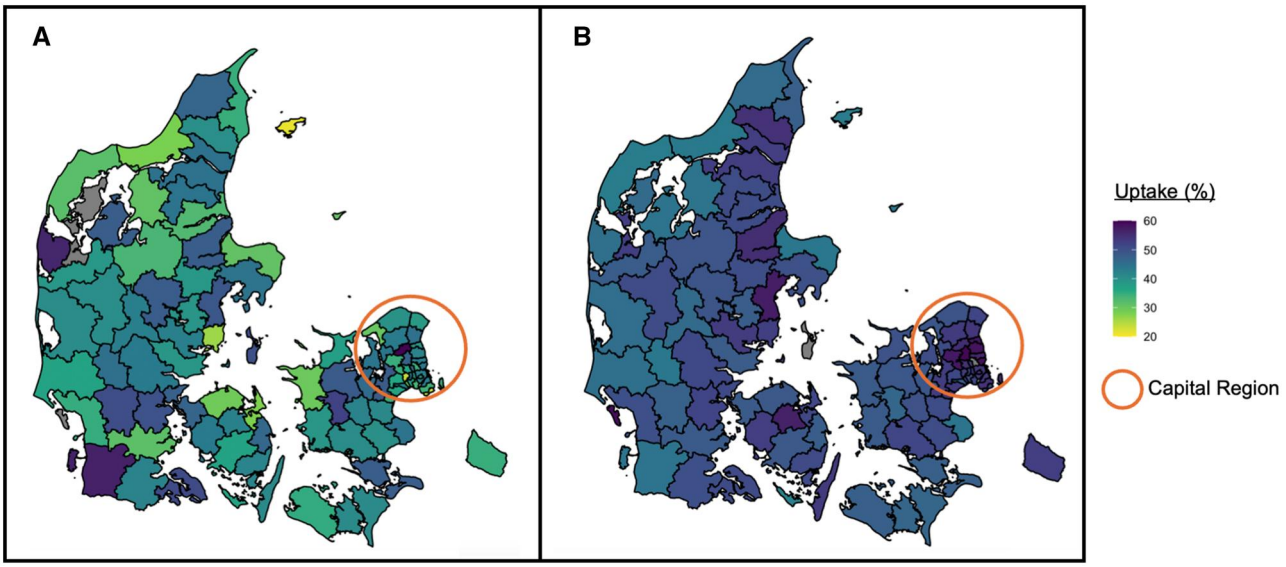

Figure 2. Map of uptake by municipality of residence in the migrant (A) and Danish-born (B) cohorts, data combined from 2015/16 to 2020/21.

worsening despite increasing calls to focus on solutions to combat low confidence and access barriers [23, 27]. Across the entire cohort, older age (>71 years) was associated with higher vaccination uptake and living in rural areas with lower uptake (compared to suburban areas). This shows the importance of further research to understand these variations in uptake and subsequently developing tailored, evidence-based approaches to vaccination campaigns for specific groups.

This study showed that quota and asylum-pathway refugees had higher uptake of influenza vaccination compared to family reunified migrants, perhaps due to initiatives such as the Danish Red Cross healthcare centers, that provide healthcare for precarious migrant groups including refugees, but which family-reunified migrants may be less likely to access [11]. Influenza vaccination uptake was also influenced by rural-urban residence in Denmark, both in the migrant and Danish-born cohorts. A skew towards higher influenza vaccine uptake in cities compared to rural areas has been previously observed in Denmark [15], as well as other settings, such as the USA [28–30] and is often attributed to greater accessibility of healthcare facilities in cities compared to rural areas. However, we have shown that among migrants in Denmark, those living in suburban areas had higher uptake rates than those living in cities. This could be due to socioeconomic or integration-related factors among migrants living in cities affecting trust in the healthcare system and vaccination. For example, in a previous study on measles vaccine coverage among Somali mothers in Norway, uptake was found to be lowest in the capital region [31], with the authors hypothesizing that larger local community networks from individual's country of origin may be more self-reliant, resulting in greater isolation from the rest of society and hindering information exchange with local healthcare providers. It is also possible that vaccine misinformation could spread more rapidly in larger, more insular, city-based community networks [31].

The findings of this study highlight changes in influenza vaccination uptake over time. In 2020/21, overall uptake increased substantially, possibly due to an improvement in the perceived importance of influenza vaccines during the COVID-19 pandemic, for example, to avoid double infections with influenza and COVID-19 [32, 33]. In the 2020/21 season, Denmark also implemented a new influenza vaccination reminder system for those aged 65 years or more, which may have improved awareness of the vaccination campaign [34]. However, during the final two seasons (2019/20 and 2020/21) the gap in uptake between the Danish and migrant cohorts widened substantially, with migrants half as likely to receive an influenza vaccine compared to Danish-born by the 2020/21 season. During the 2020/21 season, this may have been at least in part due to an increasing sense of marginalization felt by some migrant groups during the pandemic and low confidence in some migrant communities around COVID-19 vaccines [6, 19, 20, 22, 35, 36]. However, considering that the gap in uptake between migrant and Danish cohorts had already widened significantly by winter 2019/20, which was mostly prior to the COVID-19 pandemic, wider factors must be involved. In recent years, Danish immigration policy has become increasingly stricter. In 2019, the new Government implemented a host of anti-immigration policies, as part of the so-called 'paradigm shift (paradigmeskiftet)', including making all granted humanitarian residence permits temporary [37, 38]. These policies have increased the precarity that many migrants live in in Denmark and may have eroded institutional trust [38]. A recent study from the UK has highlighted the negative influence of low institutional trust and restrictive immigration policies on vaccination decision-making among precarious migrants [7], which given the increasingly hostile political context in Denmark, may be a factor in the widening influenza vaccination uptake gap that we observed between migrants and Danish-born.

It was also noticeable in our results that by the 2020/21 season, those resident 11–20 years in Denmark were less likely to be vaccinated than those more newly arrived (OR: 0.76; 95% CI: 0.61–0.95). Associations between lower vaccine confidence and more time spent in the host country have previously been observed in a minority of studies, including among Karen refugees in the USA [39] and Somali immigrants in Norway [31], with the US-based study suggesting that this may be due to deepening distrust of the healthcare establishment over time. This suggests that the increasingly hostile political context in Denmark and the COVID-19 pandemic may have exacerbated existing marginalization, socioeconomic differences, or structural racism experienced by those residing in Denmark for longer time periods, leading to deeper distrust in vaccination among these groups. This highlights the importance of including more established migrant communities in co-designing vaccine campaigns, as well as those who have recently arrived, as well as evaluating the long-term public health impacts of hostile immigration policies and holding Governments to account for negative impacts.

Whilst this study is a comprehensive and unique analysis of influenza vaccine uptake among a large cohort disaggregated by

migrant status, the dataset does not include migrants' vaccinations from travel clinics or refugee centers. However, as refugees were the group with the highest uptake in the migrant cohort, and influenza is not a key vaccine offered at travel clinics, this limitation is likely to be minimal. The dataset also did not include data on other migrant groups, such as labor migrants, asylum seekers, and undocumented individuals, who have previously been shown to have low uptake for some vaccines [20]. Further research could expand this research to include these groups, to widen the knowledge base around factors affecting influenza vaccine uptake among different migrant groups.

In conclusion, we have shown that, while influenza vaccination coverage in Denmark has increased since 2015, uptake is consistently lower among family-reunified migrants and refugees than Danish-born individuals. This gap in uptake has widened over time, rather than improving, suggesting that novel strategies may be needed to improve uptake. These findings from Denmark are likely generalizable across other high-migrant receiving countries in Europe, where, in most cases, data are lacking and large population-level cohorts do not exist. Efforts should involve co-designing interventions and communication around vaccination with the specific communities shown to have lower uptake, such as family reunified migrants and those originating from some countries in Sub-Saharan Africa, to increase confidence, trust, and subsequently uptake, of influenza vaccination and indeed all routine vaccinations across the life-course.

Supplementary data

Supplementary data are available at *EURPUB* online.

Conflict of interest: The authors declare no conflicts of interest.

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Data availability

Further data to support the findings of this study are available on reasonable request from the corresponding author. The complete dataset is not publicly available due to restrictions on access to national registry data for data protection reasons.

Key points

- This large and unique dataset show that family-reunified migrants and refugees have lower uptake rates for influenza vaccination compared with Danish-born individuals.
- The gap in uptake has widened over time, rather than improving, with the COVID-19 pandemic and distrust in COVID-19 vaccines likely to have had an impact.
- We have shown specific communities have lower uptake, such as family reunified migrants and those originating from some countries in Sub-Saharan Africa.
- Novel strategies will be needed to improve confidence and uptake, including co-designing interventions with individual communities

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