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COVID-19: incidence and mortality in Sweden comparing all foreign-born to all Swedish-born individuals in different occupations in an unvaccinated cohort of year 2020

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ABSTRACT

Objectives The aim was to analyse the incidence and mortality of COVID-19 in immigrants compared with Swedish born in inpatients and outpatient registers, respectively.

Methods The study population included all persons 20–88 years of age living in Sweden, 31 December 2019, including 1 676 516 foreign-born persons and 6 037 151 Swedish-born persons. The outcome was clinical cases of COVID-19 with a positive PCR test (ICD-10 U07.01) or without a positive PCR test (U07.2) from 1 January to 31 December 2020. Persons 20–64 years of age were classified with occupational titles according to the Swedish Standard Classification of Occupations. Residing municipality of each individual was coded according to the Swedish Association of Local Authorities. Relative risks (RR) were calculated by sex in 5 years age bands using Swedish born as reference. Age-adjusted RRs (adj RR) with 95% CIs were calculated in a Poisson regression model. Rural municipalities were used as the reference category.

Results Foreign born had consistently higher RRs in COVID-19, regardless of sex, with a peak in 50–69 years of age. Foreign born had a higher RR of death in COVID-19 above 50 years and 40 years of age in women and men, respectively. Among occupations, male drivers had the highest adj RR 4.37 (95% CI 3.45 to 5.54) and 5.09 (4.26 to 6.07) in outpatients and inpatients, respectively (U07.1). Persons living in commuting municipalities did not show any consistent increased risk for COVID-19.

Conclusion Foreign born have a higher risk of COVID-19 compared with Swedish-born individuals at any age and occupation before vaccination began in 2021.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Smaller population studies have indicated that immigrants are more severely affected by COVID-19, especially in high-risk contact trades.

WHAT THIS STUDY ADDS

⇒ In a total population study of all Swedish inhabitants, we could show that foreign-born individuals had a higher risk compared with Swedish born to be infected by SARS-CoV-2. Foreign born, especially men, had a higher risk of COVID-19 in contact trades compared with Swedish born in the same occupation.

⇒ This pattern remained regardless of positive PCR test, clinical cases of COVID-19 or death in a population before vaccination began.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ In case of a new pandemic, precautionary measures needs to be considered in vulnerable populations such as contact trades and frontline occupations as well as foreign born in the same occupations.

BACKGROUND

Since the first reported case in Sweden on 31 February 2020,[1] until phase one of vaccinations starting on 27 December 2020,[2] immigrant groups have been more severely affected by COVID-19 compared with Swedish-born citizens, even after adjusting for known determinants such as age, demographics and socioeconomic status.[3] This was particularly salient during the spring of 2020, with people born in Northern Africa and the Middle East possessing mortality rates three times higher among men, and two times higher among women compared with Swedish born.[4] A report from The Swedish Public Health Agency showed that the need for inpatient care for COVID-19 was higher among those from all foreign birth regions except North America, with the relative risk (RR) being more than five times higher among those from Africa and the Middle East compared with Swedish born.[5] Regardless of country of birth, age was the greatest risk factor for COVID-19-related death, supporting previous literature suggesting age significantly increases the risk for severe COVID-19.[6] These results are in line with international research emphasising that ethnic minorities have been disproportionately affected by COVID-19 compared with Swedish-born citizens.[7–9]

In a study examining the most affected region in France during the first pandemic wave, differences in excess mortality among immigrants were particularly high among those working age, with sub-Saharan Africans having as much as an 8–9 times elevated mortality risk.[10] Another study observing four different hospitals in Quebec found that out of a total of 1104 patients (mean age=63 years) hospitalised for COVID-19 infection between 1 March and 30 June 2020, 57% were immigrants although only accounting for 32% of the population.[11] Even though significant heterogeneities did exist between ethnicities and outcomes of COVID-19, immigrants were in general overrepresented in terms of hospitalisation, with the Caribbean black population being significantly at risk for intensive care unit (ICU) admission and in-hospital mortality.[11] In the Swedish context, educational level, disposable income and being foreign born have all independently been associated with severe COVID-19 and the need for intensive care,[12] highlighting the immigrant background and socioeconomic status as possible determinants for severe COVID-19.

Socioeconomic status and crowded living conditions are presumed to be contributing factors to immigrants' increased risk of COVID-19. Rostila *et al*[13] found that housing and socioeconomic conditions could explain one-half to two-thirds of the excess relative mortality risk among foreign born in Sweden between 31 January and 4 May 2020. Guttmann *et al*[14] highlight that even though foreign born generally were less likely to get tested and more likely to test positive compared with Swedish-born citizens, those who had the highest risk of infection were immigrants with lower education/language ability, those who came as refugees and those living in crowded housing and low-income neighbourhoods. Immigrants residing in Organisation for Economic Co-operation and Development (OECD) countries are twice as likely to stay in overcrowded living arrangements compared with Swedish borns, placing them at a higher risk of SARS-CoV-2 exposure.[15] In Stockholm, Brandén *et al*[16] also found an increased COVID-19 mortality risk for those living in the most densely populated areas (≥5000 persons/km^2) compared with those least populated (0 to <150 persons/km^2) between 12 March and 8 May 2020.

Being employed in high-risk occupations has also been suggested as a possible risk factor disproportionately affecting immigrants, although studies show mixed results. In one register-based study comparing occupational exposure between 1 January 2020, and 28 February 2021, foreign-born workers in essential occupations were at a higher risk of SARS-CoV-2 infection, hospitalisation and ICU admission compared with Swedish borns within the same occupations.[17] Similar research from the USA also shows that the effects of COVID-19 on excess mortality were greatest among those in essential occupations, with ethnic minorities being particularly affected.[18] One study examining occupational effects on frontline/essential workers in the Swedish population between 12 March 2020, and 23 February 2021, found that taxi and bus drivers were the ones most heavily affected, having more than four times higher relative to COVID-19 mortality risk compared with non-essential work such as information technology, economics or administration. However, when adjusting for socioeconomic conditions, no occupational groups were associated with a significantly increased mortality risk, suggesting these instead best explain differences in COVID-19 mortality.[19]

In our previous study, we showed that there was an increased risk of staff absence among healthcare personnel and residential care workers in Sweden due to COVID-19.[20] Sweden has a high number of immigrants, and foreign-born citizens now constitute around one-fourth of the potential workforce.[21] It is thus important to better understand any differences between immigrants and Swedish-born citizens as well as possible variations in occupational exposure that can be used in prevention regarding COVID-19 and any other future pandemic.

AIM

The aim of the present study was (1) to study the incidence and mortality of COVID-19 among adult immigrants compared with Swedish-born citizens and (2) to identify different occupations with contact trade and analyse whether immigrants have a higher risk of COVID-19 compared with Swedish born in the same trade.

METHODS

The study population at baseline consisted of all persons born 1932 to 1999, including all foreign-born persons and every Swedish-born person living in Sweden on 31 December 2019. Foreign born could be born in any country outside Sweden and the definition of Swedish born was a person being born in Sweden. Hence, 1 676 516 foreign born (835 221 women and 841 295 men) and 6 037 151 Swedish born (3 000 750 women and 3 036 401 men) were included in the study. This population was defined by Statistics Sweden using a key between the social security number and a serial number. This key was used by The National Board of Health and welfare to match with the national disease register for inpatients and outpatients, but also the national register of causes of death. It is mandatory for all caregivers in Sweden to report to these registers. All individuals were followed in these registers from 1 January to 31 December 2020. The definition of the outcome was the first clinical case diagnosed in each individual, during the follow-up period, of COVID-19 with a positive PCR test (ICD-10 code of U07.1) or COVID-19 without a positive PCR test (U07.2), respectively. The database was made available from Statistics Sweden in an anonymised dataset with serial number, diagnosis, year of birth, sex, information on the municipality of living and occupational code.

All working individuals in Sweden are coded on occupational titles provided by employers on a yearly basis and classified based on the Swedish Standard Classifications of Occupations—SSYK2012.[22] SSYK is a national adaptation to the International Standard Classification of Occupations (ISCO-08) and is a hierarchical classification with four levels (from 1 to 4 digits codes), based on the type of work performed and the skill level required.[23] Based on the number of cases, we identified some occupations with à priori expected higher risk of COVID-19 having similar educational backgrounds. Selected occupational groups included SSYK code 22 and 23 corresponding to ISCO-08 health and teaching professionals (including medical doctors, nurses, other health workers, teachers at various levels and other teaching professionals), SSYK code 51–53 corresponding to ISCO-08 personal service, sales and personal care workers (including conductors, cooks, waiters, shop salespersons, child care workers, personal care workers in health services) and SSYK 83 corresponding to Drivers and Mobile Plant Operators (including locomotive engine, truck, taxi and bus drivers).

As commuting to work is a potential risk factor for COVID-19, classification was also performed based on the municipality code of each individual's residing municipality using the system developed by the Swedish Association of Local Authorities and Regions, online supplemental appendix 1.[24]

Statistical analyses

RRs were calculated in five years age bands for foreign-born women and men using Swedish born as their references (ref

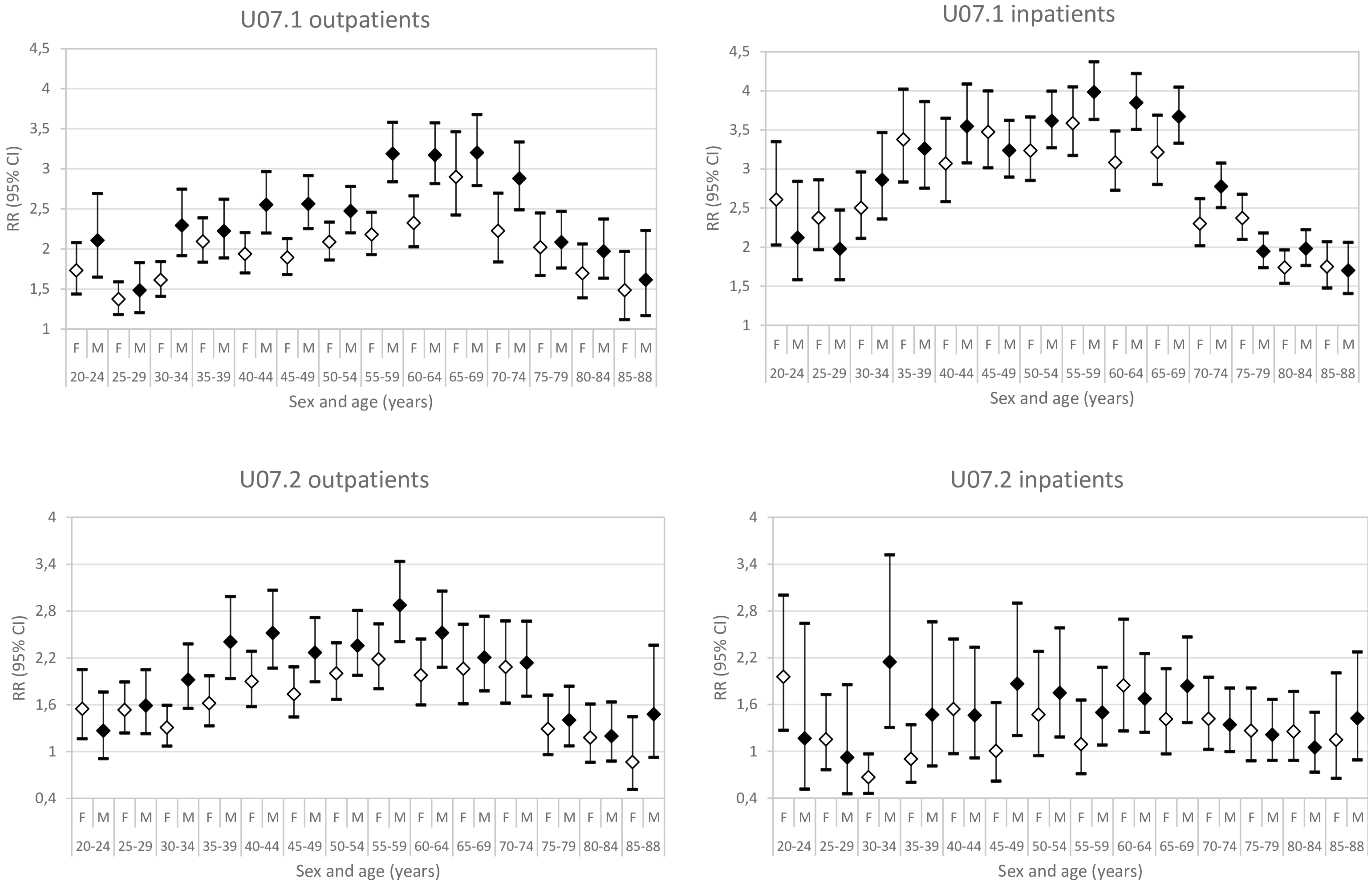

Figure 1 Relative risk (RR) with 95% CI for foreign-born females (F) and males (M) versus their Swedish-born references (ref 1.00) with clinical COVID-19 having a positive PCR test (ICD-10 code of U07.1) or without a positive PCR test (ICD-10 code of U07.2), respectively.

1.00) in each age band. Age-adjusted relative risks (adj RR) were calculated using age in 2020 as a continuous variable applying a Poisson regression model. Analysis by residing municipalities used small towns/urban areas and rural municipalities (category C) as the reference (ref 1.00). All statistical analyses were performed in SAS, statistical package, V.9.4.

RESULTS

The number of cases in 2020 is presented in 5-year age bands divided into foreign-born and Swedish-born individuals for outpatients, inpatients and deaths, respectively, online supplemental appendix 2. Corresponding descriptive data and crude incidence rate per 1000 inhabitants divided by occupational groups are presented for persons 20–64 years of age 31 December 2019, online supplemental appendix 3 .

The foreign-born individuals had a higher RR compared with the Swedish born for almost all 5-year age band, regardless of sex, with a peak of 50–69 years of age. Men tended to have higher RRs in each 5-year age band, compared with women, figure 1. Foreign-born individuals had a significantly higher risk of death in COVID-19 above 50 years of age in women and above 40 years of age in men, but the RR between foreign born versus Swedish born decreased above 60 years of age in both sexes, table 1.

The selected occupational groups had increased adj RR, both for foreign and Swedish born, when all other professions were used as the reference category, table 2.

Analysing occupational groups, foreign born had adj RR from about 2–4 for both sexes using the Swedish-born individuals as a reference in each of these groups. Again, men had in general higher risk estimates compared with women in each occupational group with drivers showing the highest adj RR, table 3.

Table 1 Relative risk (RR) with 95% CI for foreign-born women and men versus their Swedish-born references (ref 1.00) deceased in clinical COVID-19 having a positive PCR test (ICD-10 code of U07.1) or without a positive PCR test (ICD-10 code of U07.2), respectively

	Death U07.1		Death U07.2	
Sex	Age (years)	RR (95% CI)	Age (years)	RR (95% CI)
Female	20–29	–	20–29	–
	30–39	0.48 (0.10 to 2.24)	30–39	–
	40–49	1.72 (0.74 to 3.97)	40–49	–
	50–59	2.16 (1.29 to 3.62)*	50–59	–
	60–69	1.84 (1.33 to 2.55)**	60–69	3.98 (1.22 to 13.05)*
	70–79	1.78 (1.49 to 2.12)**	70–79	1.28 (0.60 to 2.70)
	80–88	1.61 (1.41 to 1.84)**	80–88	1.33 (0.74 to 2.40)
Male	20–29	0.47 (0.06 to 3.78)	20–29	–
	30–39	1.09 (0.37 to 3.20)	30–39	–
	40–49	3.53 (1.99 to 6.27)**	40–49	–
	50–59	4.48 (3.33 to 6.02)**	50–59	0.64 (0.08 to 5.35)
	60–69	2.92 (2.41 to 3.54)**	60–69	3.11 (1.22 to 7.89)*
	70–79	2.09 (1.84 to 2.39)**	70–79	1.18 (0.56 to 2.48)
	80–88	1.79 (1.58 to 2.02)**	80–88	1.62 (0.87 to 3.00)

–means no cases.
*P<0.05, **p<0.001 (Fisher's exact test).

Table 2 Age-adjusted relative risk (adj RR) with 95% CI in each occupational group, divided into foreign and Swedish born, with 'all other professions' as the reference category in each sex (ref 1.00)

				U07.1 outpatients	U07.2 outpatients	U07.1 inpatients	U07.2 inpatients
SSYK2012	Sex	Born	Occupation†	Adj RR (95% CI)	Adj RR (95% CI)	Adj RR (95% CI)	Adj RR (95% CI)
22–23‡	Female	Foreign	All other (ref)	1.73 (1.48 to 2.02)**	1.27 (1.03 to 1.56)*	1.16 (0.97 to 1.40)	–
		Swedish	All other (ref)	2.36 (2.13 to 2.60)**	1.23 (1.08 to 1.41)*	1.48 (1.33 to 1.66)**	0.96 (0.71 to 1.30)
	Male	Foreign	All other (ref)	1.97 (1.70 to 2.28)**	1.16 (0.90 to 1.51)	1.42 (1.21 to 1.67)**	1.35 (0.76 to 2.42)
		Swedish	All other (ref)	2.39 (2.08 to 2.74)**	1.28 (1.04 to 1.59)*	1.55 (1.35 to 1.77)**	1.08 (0.70 to 1.67)
51–53§	Female	Foreign	All other (ref)	2.36 (2.10 to 2.64)**	1.58 (1.37 to 1.83)**	1.72 (1.52 to 1.94)**	–
		Swedish	All other (ref)	2.10 (1.92 to 2.30)**	1.25 (1.12 to 1.39)**	1.54 (1.40 to 1.69)**	1.38 (1.10 to 1.73)*
	Male	Foreign	All other (ref)	1.68 (1.50 to 1.88)**	1.48 (1.26 to 1.75)**	1.54 (1.38 to 1.72)**	1.75 (1.21 to 2.53)*
		Swedish	All other (ref)	1.58 (1.39 to 1.79)**	1.43 (1.23 to 1.67)**	1.40 (1.25 to 1.57)**	1.02 (0.72 to 1.45)
83¶	Female	Foreign	All other (ref)	1.23 (0.50 to 3.00)	1.05 (0.33 to 3.32)	0.70 (0.21 to 2.26)	–
		Swedish	All other (ref)	0.66 (0.31 to 1.42)	1.72 (1.03 to 2.86)*	0.26 (0.08 to 0.87)*	1.62 (0.53 to 4.89)
	Male	Foreign	All other (ref)	1.40 (1.19 to 1.63)**	1.35 (1.07 to 1.70)*	1.70 (1.49 to 1.95)**	2.28 (1.48 to 3.49)**
		Swedish	All other (ref)	0.85 (0.69 to 1.05)	1.35 (1.10 to 1.65)*	1.15 (0.99 to 1.34)	1.24 (0.84 to 1.84)
Missing††	Female	Foreign	All other (ref)	1.28 (1.14 to 1.44)**	1.23 (1.07 to 1.42)*	1.66 (1.48 to 1.87)**	–
		Swedish	All other (ref)	1.14 (1.01 to 1.30)*	1.67 (1.48 to 1.89)**	1.88 (1.70 to 2.09)**	1.99 (1.56 to 2.54)**
	Male	Foreign	All other (ref)	1.02 (0.93 to 1.11)	1.08 (0.95 to 1.22)	1.21 (1.12 to 1.32)**	1.65 (1.26 to 2.16)**
		Swedish	All other (ref)	1.15 (1.03 to 1.29)*	1.44 (1.28 to 1.62)**	1.56 (1.44 to 1.69)**	3.04 (2.55 to 3.63)**

–means no cases.
Age-adjusted relative risks are presented in working age 20–64 years by job titles in the Swedish Standard Classifications of Occupations (SSYK2012) and given as clinical cases of COVID-19 with a positive PCR test (ICD-10 code of U07.1) and clinical cases of COVID-19 without a positive PCR test (ICD-10 code of U07.2), respectively.
*P<0.05.
†All other SSYK-codes lumped together.
‡Corresponding to ISCO-08 code 22 Health Professionals and 23 Teaching Professionals.
§Corresponding to ISCO-08 code 51 Personal Service Workers, 52 Sales Workers and 53 Personal Care Workers.
¶Corresponding to ISCO-08 code 83 Drivers and Mobile Plant Operators.
**P<0.001.
††Missing code according to SSYK, for example, unemployed, students.
ISCO-08, International Standard Classification of Occupations.

When analysing data by municipalities, we could not identify any consistent pattern in adj RR for individuals of working age (20–64 years) residing in municipalities classified as commuting municipalities (category A2 and B2), either for foreign born or Swedish born using rural municipalities as the reference (category C). The reference category had the lowest risk of COVID-19 in comparison with A1–B3. Foreign born had higher adj RR versus Swedish born

Table 3 Age-adjusted relative risk (adj RR) with 95% CI for foreign-born women and men versus their Swedish-born references (ref 1.00) with COVID-19

		U07.1 outpatients	U07.2 outpatients	U07.1 inpatients	U07.2 inpatients
SSYK2012	Sex	Adj RR (95% CI)	Adj RR (95% CI)	Adj RR (95% CI)	Adj RR (95% CI)
22–23†	Female	1.41 (1.20 to 1.66)**	1.77 (1.44 to 2.17)**	2.26 (1.88 to 2.72)**	1.56 (1.00 to 2.43)*
	Male	2.04 (1.67 to 2.49)**	2.18 (1.65 to 2.87)**	3.12 (2.57 to 3.78)**	1.93 (0.95 to 3.94)
51–53‡	Female	2.16 (1.97 to 2.37)**	2.14 (1.87 to 2.46)**	3.20 (2.90 to 3.53)**	1.15 (0.86 to 1.54)
	Male	2.59 (2.28 to 2.96)**	2.35 (1.91 to 2.90)**	3.60 (3.14 to 4.14)**	2.58 (1.63 to 4.08)**
83§	Female	4.09 (1.58 to 10.59)*	1.01 (0.33 to 3.07)	7.82 (1.56 to 39.17)*	–
	Male	4.37 (3.45 to 5.54)**	2.44 (1.87 to 3.19)**	5.09 (4.26 to 6.07)**	2.79 (1.74 to 4.45)**
All other¶	Female	1.95 (1.75 to 2.18)**	1.70 (1.47 to 1.97)**	2.89 (2.55 to 3.27)**	1.07 (0.76 to 1.50)
	Male	2.54 (2.32 to 2.78)**	2.28 (2.03 to 2.56)**	3.36 (3.09 to 3.65)**	1.51 (1.16 to 1.96)*
Missing††	Female	2.19 (1.97 to 2.44)**	1.25 (1.11 to 1.42)**	2.59 (2.37 to 2.84)**	0.87 (0.67 to 1.15)
	Male	2.26 (2.01 to 2.54)**	1.77 (1.57 to 2.00)**	2.67 (2.42 to 2.95)**	0.83 (0.66 to 1.03)

–means no cases.
Age-adjusted relative risks are presented in working age 20–64 years by job titles in the Swedish Standard Classifications of Occupations (SSYK2012) and given as clinical cases of COVID-19 with a positive PCR test (ICD-10 code of U07.1) and clinical cases of COVID-19 without a positive PCR test (ICD-10 code of U07.2), respectively.
*P<0.05.
†Corresponding to ISCO-08 code 22 Health Professionals and 23 Teaching Professionals.
‡Corresponding to ISCO-08 code 51 Personal Service Workers, 52 Sales Workers and 53 Personal Care Workers.
§Corresponding to ISCO-08 code 83 Drivers and Mobile Plant Operators.
¶All other SSYK-codes lumped together.
**P<0.001.
††Missing code according to SSYK, for example, unemployed, students.
ISCO-08, International Standard Classification of Occupations.

in each of the subdivisions, hence not explained by living in a commuting municipality, but instead by being foreign born (data not shown).

DISCUSSION

Our main findings were that foreign-born individuals had a higher risk compared with Swedish born to be infected by SARS-CoV-2 and that men have a tendency for a higher risk of COVID-19 compared with women. This confirms previous observations in Sweden.[3 4 13 17 19] The registers could not provide any information whether men, and especially foreign-born men, have another risk behaviour, or if our results indicate another exposure panorama compared with the reference. Foreign-born individuals had a significantly higher risk of death in COVID-19 at working age compared with Swedish born, a difference less pronounced in the elderly. Foreign born, especially men, had a higher risk in contact trades compared with Swedish born in the same occupation with drivers showing the highest adj RR. Contact trades have in previous studies also been identified as risk occupations such as taxi/bus drivers.[19 25] Frontline workers such as health and teaching professionals and personal service and care workers can also be considered as having a contact trade which we also could identify as risk occupations, confirming previous findings.[17 19] It is important to consider that frontline workers in many cases need to have a negative PCR test before going back to work after sickleave which can result in more intense testing in these trades. In Canada, the rates of testing were lower among immigrants and refugees compared with Canadian-born citizens.[14] However, we did not have access to testing data, but if foreign born would have a lower rate of testing than Swedish born our results could potentially being underestimating the differences found in our cohort. Our analysis could not confirm that living in a commuting municipality was a risk factor for COVID-19, although our results show that the incidence of COVID-19 was lowest in the most sparsely populated municipalities.

The major strength of this study is that the total Swedish population is included with contrast in exposure by using a Swedish-born reference population before commencing vaccination. The relatively narrow confidence intervals show that we have achieved statistical power in almost all our subgroup analyses, making it unnecessary to speculate whether foreign born are less likely to be tested for SARS-CoV-2 infection. Early in the pandemic, test capacity and quality of the PCR tests were limited and by included both the diagnosis of U07.1 and U07.2, with similar results we could with reasonable certainty include all cases of COVID-19 occuring in year 2020. By selecting occupational categories with the same educational requirements, confounding by socioeconomic status could be minimised. Our categorisation of occupational titles relied on the annual information provided by the register of 31 December 2019. Therefore, we could not account for any labour market changes due to the COVID pandemic or if a person changed occupation due to a disease. However, as our follow-up period was limited to one calendar year, we believe this limitation to be of minor importance for our results. The accuracy of classifying immigrants and Swedish born is high with negligible misclassification. We have used national registries and therefore all inpatients with a diagnosis of COVID-19 diagnosis have been retrieved. Validation has shown that the primary diagnosis is listed in 99% of all hospital discharges.[26] The coverage in the register of specialised outpatient care is less comprehensive and to the best of our knowledge, a similar validation has not yet been performed. Another limitation is that we have no information on the number of persons sharing the same household. Therefore, we cannot completely disentangle whether the increased risk for foreign born is an effect of different exposure due to different work tasks compared with Swedish born, or if the SARS-CoV-2 infection is transmitted in the household because of overcrowding. Also, we do not differentiate between immigrants from different geographical origin, but such differences likely exist, but it was not an aim of our study to give any particular ethnic group a stigma of being identified as particularly vulnerable for transmitting the disease.

CONCLUSIONS

Our study supports earlier findings of foreign born having a higher risk of COVID-19 compared with Swedish born at any age and occupation, regardless of sex, with a peak of 50–69 years of age, before the vaccination campaign commenced. Contact trades and frontline occupations were identified as risk groups with higher risks of COVID-19 in foreign born compared with Swedish born in the same occupation. Although relatively few cases of death occurred at working age, the foreign born still had a higher risk of COVID-19 above 50 years of age compared with the Swedish-born individuals.

Future research should disentangle and quantify the relative relationship between congested living and other contributing socioeconomic factors, compliance with precautionary recommendations stratified by sex, work tasks in different occupations, testing and vaccination rates in different subgroups of the population in order to prepare for efficient actions in case of a new pandemic.

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Competing interests None declared.

Patient consent for publication Not applicable.

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Data availability statement Data may be obtained from a third party and are not publicly available. All data relevant to the study are included in the article or uploaded as supplementary information. The datasets generated and analysed in our study are not publicly available due to privacy reasons after a non-disclosure agreement with the National Board of Health and Welfare providing us with the diagnoses of COVID-19 from national registers for inpatients,outpatients and causes of death, respectively. We also have a binding agreement with the regional Ethics committee in Uppsala and the Swedish Ethical Review Authority not to disclose individual data. These medical data are stored for 10 years according to the policy of Uppsala University for Medical Research Data. Data can only be made available to researchers who meet the criteria for access to confidential data following a decision by the Uppsala University Institutional Data Access Committee.

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