Scandinavian Journal of Public Health, 2022; 50: 52–60

ORIGINAL ARTICLE

The correlation between socioeconomic factors and COVID-19 among immigrants in Norway: a register-based study

MARTE KJØLLESDAL[1], KATRINE SKYRUD[1], ABDI GELE[1], TRUDE ARNESEN[2], HILDE KLØVSTAD[2], ESPERANZA DIAZ[1,3] & THOR INDSETH[1]

[1]Health Services Research, Norwegian Institute of Public Health, Oslo, Norway, [2]Division of Infection Control and Environmental Health, Norwegian Institute of Public Health, Oslo, Norway, and [3]Department for Public Health and Primary Care, University of Bergen, Bergen, Norway

Abstract

Aim: Immigrants in Norway have higher COVID-19 notification and hospitalisation rates than Norwegian-born individuals. The knowledge about the role of socioeconomic factors to explain these differences is limited. We investigate the relationship between socioeconomic indicators at group level and epidemiological data for all notified cases of COVID-19 and related hospitalisations among the 23 largest immigrant groups in Norway. *Methods:* We used data on all notified COVID-19 cases in Norway up to 15 November 2020, and associated hospitalisations, from the Norwegian Surveillance System for Communicable Diseases and the emergency preparedness register at the Norwegian Institute of Public Health. We report notified COVID-19 cases and associated hospitalisation rates per 100,000 and their correlation to income, education, unemployment, crowded housing and years of residency at the group level. *Results:* Crowded housing and low income at a group level were correlated with rates of both notified cases of COVID-19 (Pearson`s correlation coefficient 0.77 and 0.52) and related hospitalisations (0.72, 0.50). In addition, low educational level and unemployment were correlated with a high number of notified cases. ***Conclusions:*** **Immigrant groups living in disadvantaged socioeconomic positions are important to target with preventive measures for COVID-19. This must include targeted interventions for low-income families living in overcrowded households.**

Keywords: *COVID-19, socioeconomic conditions, immigrants, migrants, hospitalisation*

Introduction

In Norway, there was a rapid increase in notified COVID-19 cases through early March 2020, then a decline in new identified cases from the end of the month. A peak in notified cases among immigrants came a few weeks later, and as total numbers declined, the proportion of immigrants among new cases rapidly increased. After the first weeks of the pandemic, immigrants have been highly overrepresented in COVID-19 notified cases and associated hospitalisations, and also in age-adjusted mortality [1].

Studies of previous crises and pandemics have shown that people with low socioeconomic status (SES) are often hit harder than people with higher SES [2], but the association between SES and infections is not constant over time and for all settings [3]. For the 1918 pandemic, SES was negatively associated with influenza-like illness in the first wave, but was positively associated in the second wave [4]. Poverty is a well-known risk factor for tuberculosis, both historically and globally, although the associations are not always linear [5]. The occurrence of H1N1 hospitalisation, severe illness and mortality were associated with social disadvantage in the USA, but not in other high-income countries [6], indicating that contextual factors in different countries might be of importance. Several explanations as to why low SES might affect the risk of COVID-19 have

Correspondence: Marte Kjøllesdal, Health Services Research, Norwegian Institute of Public Health, Postboks 222 Skøyen, Oslo, 0213, Norway.
E-mail: makj@fhi.no

Date received 22 December 2020; reviewed 26 March 2021; accepted 9 April 2021

DOI: 10.1177/14034948211015860
journals.sagepub.com/home/sjp
SAGE

been put forward, including cramped living conditions, occupational exposure, lack of ability to work from home, frequent use of public transport, poor nutritional status, concurrent illnesses, low health literacy and lack of understanding of or access to health advice and health services. Severe COVID-19 is closely linked to comorbidities with an established social gradient, such as hypertension, diabetes, cardiovascular disease or respiratory diseases [7, 8].

Scandinavian countries are comparable over a range of factors, including welfare systems and health. In Sweden, immigrants from most countries, and especially from low and middle-income countries, have an increased risk of death from COVID-19 [9–11]. Swedish studies also indicate that some occupational groups, including taxi drivers and public transport operators, as well as workers in the interpreting industry, restaurant and service industry are at increased risk of being infected with COVID-19, and that people with lower education and less income are at high risk of death from COVID-19 [12]. Several immigrant groups are overrepresented in such occupations and in low-income and educational groups. Also in Denmark, non-western immigrants have a higher incidence of COVID-19 than Danish-born individuals, and also an increased risk of COVID-19-related hospitalisation, but not of related mortality [13]. Immigrants had a higher proportion of positives among tested across occupational groups, but this could be due to higher proportions of immigrants in occupations with a higher risk of COVID-19 infection. Crowded housing was also associated with a higher risk of COVID-19. A Norwegian study also found an increased risk of COVID-19 associated with some occupations commonly held by immigrants, including taxi, bus and tram drivers [14].

Studies from the USA and the UK have associated some ethnic backgrounds, but also low income and poverty, with an increased risk of death from COVID-19 [15–21]. However, low SES could not explain the association between ethnicity and the increased risk of severe outcomes of COVID-19 infection. One should be careful to transfer these findings to Norway, first and foremost because both the prevalence of infection, ethnic composition, economic differences and working conditions are so radically different from Norway. Further, being an immigrant is radically different from being in an ethnic minority group which has lived in England or the US for generations. Nevertheless, these findings provide some support for the assumption that social inequalities are important for COVID-19 infection and an increased risk of serious consequences of COVID-19 also in Norway. In general, immigrants in Norway are over-represented in lower socioeconomic groups, with lower levels of education, lower income, higher rates of unemployment and a higher proportion living in crowded housing than the general population, but with variation by region of origin [22].

To the best of our knowledge the relationship between socioeconomic factors, immigration status and COVID-19 rates and hospitalisations has not been studied in Norway. We hypothesis that the socioeconomic profile of an immigrant group is important for the individual risk of COVID-19, as the risk associated with one's own socioeconomic profile may be overtaken by the risk associated with the socioeconomic status of your closest social network. We aim to answer the question as to whether socioeconomic differences can explain an excess burden of COVID-19 among immigrants by investigating the correlation between socioeconomic factors (income, unemployment, education, crowded housing and duration of residency) at the group level and COVID-19 and related hospitalisations among immigrants and non-immigrants in Norway.

Methods

Physicians and laboratories are obligated to report all confirmed cases of COVID-19 with epidemiological, clinical and microbiological information to the Norwegian Surveillance System for Communicable Diseases (MSIS) using standard case-based notification practices. As part of the legally mandated responsibilities of the Norwegian Institute of Public Health (NIPH) during epidemics, a new emergency preparedness register covering the entire Norwegian population was established in April 2020 [23]. In cooperation with the Norwegian Directorate of Health, data from MSIS and the Norwegian patient register from 1 January 2020, was compiled and linked at the individual level using the unique personal identification number provided to everyone in Norway at birth or on immigration.

Aggregated data

Aggregate data on the number of immigrants, by country of birth for the population above 16 years of age, was collected online at Statistics Norway (ssb.no). In addition, several measures of the SES by country of birth were collected from the same data source. In Table I, we describe the definitions of the socioeconomic variables included in this study: index of income per consumption unit, proportion of unemployed, proportion with only high school education, proportion with college degree, proportion living in crowded housing, proportion with years of

Table I. Definitions of the socioeconomic status variables collected from Statistics Norway.

Variable	Definition	Age included
Income	After-tax per consumption unit (EU scale), index (the whole population = 100) (%)	All ages
Unemployment	Registered unemployed immigrants and persons participating in labour market schemes (%)	15–74 Years
High school degree	Educational attainment up to high school degree: 'basic school level', 'upper secondary education' and 'tertiary vocational education' (%)	⩾16 Years
College degree	Educational attainment college degree or higher: 'higher education, short' and 'higher education, long' (%)	⩾16 Years
Crowded housing	Proportions living in crowded dwelling (<1 room per person (excluding kitchen, bathroom) and/or <20 m^2 per person) (%)	⩾16 Years
Years of residency ⩽5	Years of residency ⩽5 years (%)	All ages
Years of residency ⩽10	Years of residency ⩽10 years (%)	All ages

residency of 5 years or fewer, and proportion with years of residency of 10 years or fewer. The aggregated measures by country of birth were collected for the year 2020, except for crowded housing, which was only available for the year 2018. The included variables are socioeconomic factors possibly related to rates of infections and available on a group level in open sources.

Variables

An immigrant is here defined as a person born outside Norway but residing in Norway with legal residence. A non-immigrant is a person born in Norway with permanent residence. Country of birth for non-residents cannot be identified in the data (and are excluded). We focus on non-immigrants and immigrants from the 23 countries with more than 10,000 persons living in Norway at the beginning of 2020 (Poland, Lithuania, Sweden, Syria, Somalia, Germany, Iraq, the Philippines, Eritrea, Pakistan, Thailand, Denmark, Iran, Russia, Afghanistan, Romania, Great Britain, Bosnia Herzegovina, India, Turkey, Kosovo and Latvia) When reporting results for immigrants as one group, we include all immigrants (i.e. not only those in the 23 groups). COVID-19-related hospitalisation is defined as a person that has both tested positive for serious acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and has been hospitalised (inpatient) at a hospital in Norway during the period of 2 days before to 14 days after the positive test.

Study population

Our study population included every person residing in Norway at 1 March 2020. Positive tests for SARS-CoV-2 were included up to 15 November 2020. To capture hospitalisation according to our above definition, the study population was followed another 14 days.

Data analysis

Notification rates were calculated as events*(100.000/population). All the socioeconomic measures at country of birth level were tested for correlation with rates of notified COVID-19 cases and associated hospitalisations (Pearson's correlation coefficient).

We conducted sensitivity analysis by re-running the correlation analyses without Pakistan and Somalia, which are the two groups with the highest rates of notified cases.

Data handling and analyses were performed using Stata version 16.1 (StataCorp) and R version 3.6.2. Institutional board review was conducted, and the ethics committee of South-East Norway confirmed (4 June 2020, #153204) that external ethical board review was not required.

Results

Both rates of notified infections and hospitalisations and socioeconomic profile varied considerably between immigrants and non-immigrants, and among immigrant groups (Table II). Numbers of notified cases and hospitalisations in each group are given in Supplemental Table I. The rate of notified cases and hospitalisations in the non-immigrant population was 1319 and 104 per 100,000. The highest rates of notified cases were seen among immigrants from Somalia (4024 per 100,000), Pakistan (3591), Iraq (2495), Afghanistan (2378) and Turkey (2125), whereas the lowest rates were seen among immigrants from Latvia (199) and Thailand (351). Somalia and Pakistan also had the highest rates of hospitalisation (466 and 545 per 100,000), whereas the lowest rates were seen among immigrants from Latvia, Lithuania, Poland and Great Britain.

In correlation analyses between group-level sociodemographic factors and incidence rates of COVID-19, there were correlations between crowded housing, low proportion of the group

Table II. Notified cases, hospitalisations and socioeconomic profile according to immigrant groups.

Country of birth	Population >16 years	Notified infections per 100,000	Hospitalisations per 100,000	Income, index	Unemployment, %	College degree, %	High school degree, %	Crowded housing, %	Years of residency <5, %	Years of residency <10, %
Norway	3,656,036	449	31	100	3.4	33.7	65.9	6.0		
Immigrants	715,238	1319	104	70	9.4	38.4	60.1	20.7	26.1	51.2
Poland	92,134	1590	26	83	11.8	30.8	69.1	20.6	24.5	61.5
Lithuania	36,382	456	16	80	10.9	40.4	59.1	17.6	28.8	80
Sweden	34,085	898	41	105	7.7	49.0	50.6	8.7	15.9	38.8
Somalia	25,519	4024	466	53	14.3	9.9	83.1	49.2	11.1	45.7
Germany	23,281	580	34	97	5.5	52.7	47.1	8.3	16.6	34.1
Syria	22,702	802	93	49	12.1	22.9	74.8	39.0	84.4	95.8
Iraq	21,966	2495	209	62	11.8	27.5	70.1	33.4	9.5	19.7
Philippines	21,577	876	107	84	9.9	51.3	48.0	19.6	29.9	56.9
Eritrea	20,013	1739	85	56	11.3	10.1	88.0	28.9	36.9	79.6
Pakistan	19,992	3591	545	72	9	28.5	67.0	40.7	13.4	24.4
Thailand	19,398	351	46	87	12.2	21.1	75.8	13.7	23.3	46.1
Denmark	18,150	672	72	102	4.7	44.7	55.2	6.3	14.6	27.9
Iran	17,439	1491	155	77	9.2	43.2	54.6	16.0	16.1	34.3
Russia	17,047	1091	100	82	9.3	54.8	45.0	21.4	13.6	32.4
Afghanistan	16,066	2378	149	63	11.2	15.7	78.3	34.2	26.1	51.6
Vietnam	13,905	575	86	83	9.0	25.6	70.3	18.3	9.4	16.6
Great Britain	13,861	743	–	102	6.7	63.2	36.4	7.1	21.9	38.8
Romania	13,746	1368	36	79	12.2	39.7	60.1	21.1	35.0	76.4
Bosnia Herzegovina	13,601	831	81	88	5.7	36.8	62.5	14.9	9.7	15.9
India	12,710	763	110	89	6.9	73.2	26.1	19.5	42.1	61.2
Turkey	11,668	2125	240	73	9.8	20.7	76.2	29.7	19.4	28.5
Kosovo	10,127	652	–	79	9.1	23.1	76.0	30.8	8.4	15.8
Latvia	9549	199	–	78	11.8	36.7	63.0	19.6	25.2	67.9

Rates of notifications and hospitalisations not shown for numbers less than 5.

Table III. Correlations between notified infections and hospitalisations per 100,000 versus several socioeconomic factors among county of birth (Pearson's correlation index).

Socioeconomic factors	Notified infections per 100,000	Hospitalisations per 100,000
Low income	0.52*	0.50*
Unemployment	0.43*	0.26
College degree or higher	–0.47*	–0.36
High school degree or lower	0.42*	0.29
Crowded housing	0.77**	0.72**
Years of residency <5	–0.21	–0.22
Years of residency <10	–0.15	–0.27

*$p<0.05$. **$p<0.01$. ***$p<0.001$.

with a high educational level, high proportions with low educational level, unemployment and low income and higher incidence rates of COVID-19 (Table III and Figure 1). Lower income and crowded housing were also correlated with rates of hospitalisation (Table III). In sensitivity analyses, excluding Somalia and Pakistan, the correlation between crowded housing and notified cases of COVID-19 and related hospitalisations was attenuated by approximately 25%. The association between income and notified cases was attenuated by approximately 20% and the association between income and hospitalisations did not change (Supplemental Table II).

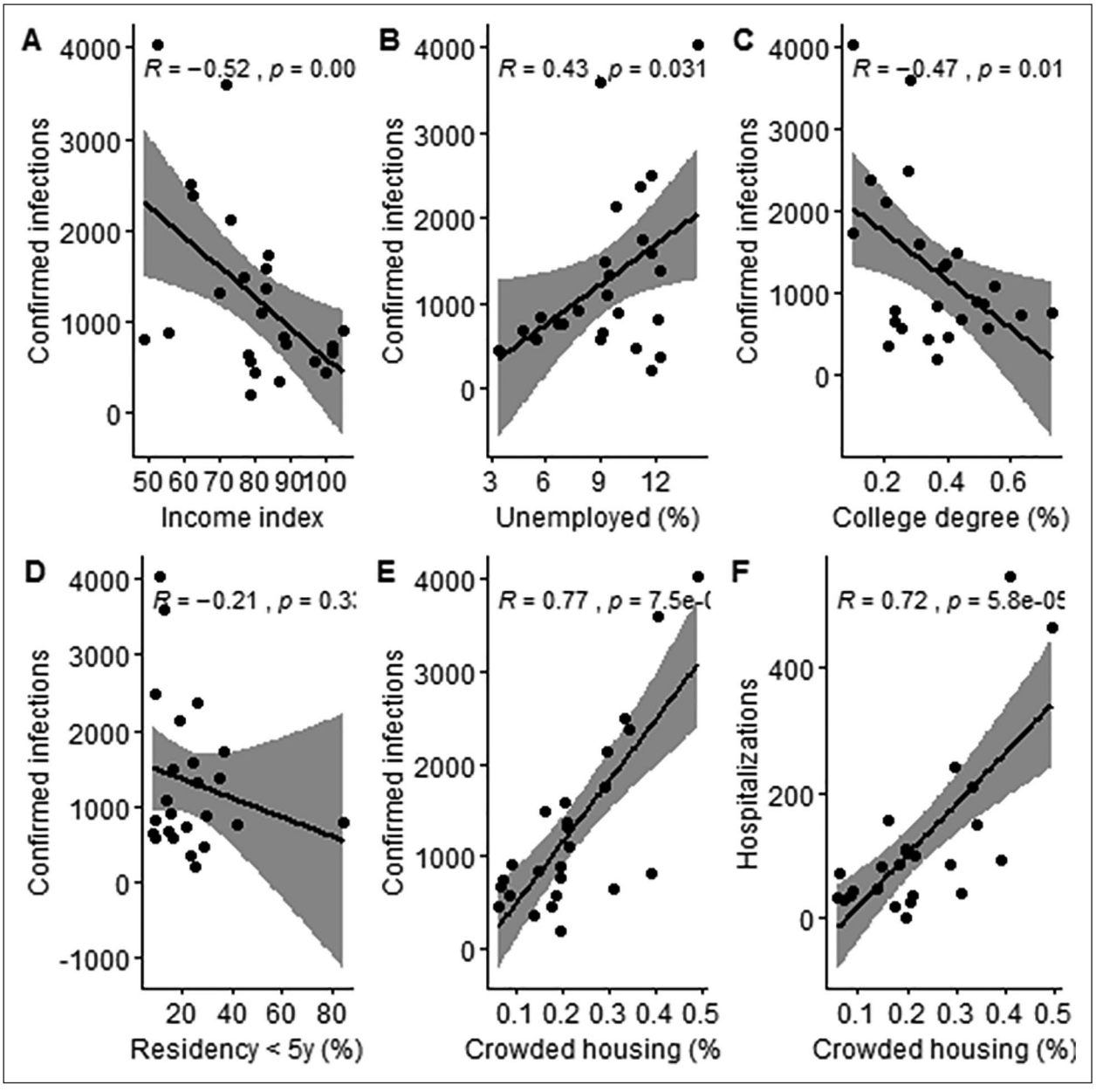

Figure 1. Correlations between notified infections and A) income B) unemployment C) college degree D) residency E) crowded housing and F) between hospitalization and crowded housing.

Discussion

The SES of immigrants at the group level was related to rates of notified infections and related hospitalisations. There was a strong correlation between notified infections and crowded housing, whereas the correlations between notified infections and income, unemployment and education were moderate.

Among the socioeconomic indicators assessed, crowded housing was most strongly correlated with rates of infection and hospitalisation. Crowded housing conditions may be associated with rates of infection in several ways. When people live close, it is difficult to keep a distance, both to household members and to visitors, and it is difficult to self-isolate and to stay home for extended periods; for example, when having symptoms of respiratory infection or when in quarantine. Crowded housing is also associated with larger households, so the total number of secondary close contacts might be higher. The uncomfortable situation at home may urge some individuals to seek socialisation outside their home even in such periods, which may fuel the spread of the virus among immigrants Studies have shown that people with low income and low educational level, as well as minority populations, consider themselves less able to self-isolate than others, even being just as willing to do so [24].

Crowded housing is most common in urban/central areas, where infection rates often are the highest. Further, crowded living conditions could be a proxy for indicators of low SES, such as low income. Living in crowded households could for some also mean living in a multigenerational household, which could increase the exposure to infections among elderly who otherwise are not exposed at, for example, work. The correlation between notified cases/hospitalisations and crowded housing was attenuated, but still significant, when excluding Somalia and Pakistan, the two groups with the highest notification rates and highest proportions living in crowded housing conditions.

Low household income was also correlated with high rates of both notified cases and of hospitalisations. People in low income households are likely to have low income occupations, which often are occupations without possibilities to work from home, and with high levels of exposure to other people [12, 14, 25]. They are also likely to be employed on short-time contracts, with a higher risk of (perceived) potential negative effects of not showing up at work, such as contracts not being prolonged. Low income may also be a barrier to efforts to protect from infections, such as buying and using face masks. In a study assessing the barriers immigrants in Norway face during the COVID-19 pandemic, several participants mentioned lack of money to buy adequate food [26], which can also relate to underlying poor health.

Lower levels of education were correlated with high rates of notified cases. Education could be a proxy of low income, but may also represent low health literacy, and possibly low proficiency in the Norwegian language in some groups. For people with low health literacy, gaining and understanding health-related information may be a challenge [27].

Length of residence did not correlate with rates of infection or hospitalisation in this study. This might be because groups with similar lengths of residence may be very different in other sociodemographic measures. For example, the groups from Syria and Somalia have different durations of residence in Norway, but are very similar in other measures of socioeconomy. It could also be that length of residence does not strongly influence adherence to infection control measures. A Swedish study from the beginning of the pandemic concluded that lack of acculturation could not explain a high incidence of COVID-19 among immigrants [28].

The correlations between socioeconomic factors at the group level and rates of notified cases and rates of hospitalisations were approximately equally strong. This may indicate that groups with high proportions with low income, or living in crowded housing, experience high levels of exposure to COVID-19 infection, and at the same time have high levels of underlying factors (such as poor health) predisposing to a severe course of the disease [7].

Our results suggest that socioeconomic differences between groups may be of some importance in explaining differences in the burden of COVID-19 between groups. However, it also suggests that other factors may be equally, or more important. Sociocultural factors such as participating in weddings, attending funerals, visiting each other and sharing information are traditions that strengthen immigrant communities by enhancing connectedness and solidarity among them. Unfortunately, during the pandemic, these traditions turned out to be risk factors for the transmission of the virus, and immigrants from several backgrounds have reported fear of negative social consequences if not attending expected gatherings (unpublished data). Data on place/situation of exposure to the SARS-Cov-2 virus are not sufficiently collected in Norway to be included in our analyses, but available data suggest that many cases of notified infections can be related to larger gatherings where infection control has, or has not, been sufficiently carried out. Such social expectations may correlate with low socioeconomic score, and thus be another mediator between country of

origin and notification rates, following the same patterns as socioeconomic factors.

Strengths and limitations

This is the first study to assess the role of socioeconomic factors in the excess burden of COVID-19 among immigrants in Norway. We use register-based data allowing us to capture all notified cases and link them to country of birth and group-level data on socioeconomic indicators. Immigrants are defined as born outside Norway. However, many non-immigrants are born in Norway to immigrant parents, and as many of these live in households with immigrant parents, their risk of and response to COVID-19 may be influenced by their immigrant parents. We assessed associations between group-level measures of socioeconomy and COVID-19. The risk associated with the socioeconomic situation in a person's network may be as important, or even more important, than risk associated with their own socioeconomic position. For example, may protection against COVID-19 infection associated with high education not be the same for highly educated persons often socialising with persons with low education as among highly educated persons mostly socialising with others with a similar level of education. Thus, group-level socioeconomic position may be an important indicator complementing information about individual-level socioeconomic position [29]. When data on individual-level socioeconomic position are available, we aim to assess further the importance of such factors for the disproportionate burden of COVID-19 among several groups of immigrants. Our findings are in line with a large study in the UK, with individual-level data on ethnicity and socioeconomy in a large sample (~400,000) [18, 19, 21]. The authors found higher rates of notified COVID-19 infections and related hospitalisations in ethnic groups other than white, among those living in the most deprived areas and among those with the lowest education [18, 19, 21]. The differences in notified infections and hospitalisations between ethnic groups could not be accounted for by differences in such socioeconomic factors. In a Swedish study, lower income and lower education predicted death from COVID-19 [30].

Implications

Socioeconomic factors seem to be moderately important for the high burden of COVID-19 among immigrants. It may be that other factors, such as lack of access to information or social pressure to attend larger gatherings, correlate with low SES at the group level, and thus explain some of our findings. This may give valuable direction to efforts for targeting immigrant communities with information about COVID-19. Nevertheless, immigrant groups with low socioeconomic position may be especially important to target with preventive measures, although the explanations for high rates of notified cases are not first and foremost directly related to socioeconomic factors.

Conclusions

Crowded housing was correlated with both COVID-19 infections and related hospitalisations. Further, low income, low education and unemployment at the group level were moderately correlated with rates of COVID-19 infections. Other characteristics of immigrant groups with disadvantaged socioeconomic position may be equally important for high rates of COVID-19. Regardless of the cause of infections, these groups are important to target with preventive measures. In particular, targeted interventions should be directed to low-income families living in overcrowded households.

Acknowledgements

The author(s) would like to thank the Norwegian Directorate of Health, in particular the Director for Health Registries, Olav Isak Sjøflot, and his department, for excellent cooperation in establishing the emergency preparedness register. They would also like to thank Gutorm Høgåsen, Ragnhild Tønnessen and Anja Lindman for their invaluable efforts in the work on the register. The interpretation and reporting of data are the sole responsibility of the authors and no endorsement by the register is intended or should be inferred. The author(s) would like to thank the municipal medical officers and medical microbiology laboratories for reporting cases and test results to the NIPH. They would also like to thank everyone at the NIPH who has been part of the outbreak investigation and response team.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Marte Kjøllesdal https://orcid.org/0000-0002-5223-711X

Abdi Gele https://orcid.org/0000-0002-3616-6411

Esperanza Diaz https://orcid.org/0000-0001-7698-4331

Thor Indseth https://orcid.org/0000-0002-2727-332X

Supplemental material

Supplemental material for this article is available online.

References

[1] Indseth T, Grøsland M, Arnesen T, et al. Covid-19 among immigrants in Norway; notified infections, related hospitalizations and associated mortality. A register based study. *Scand J Public Health* 2021;49(1):48-56. DOI: 10.1177/1403494820984026. Epub 2021 Jan 7.

[2] Hernæs ØM. Kriser rammer sosialt skjevt. *Stat & Styring* 2020;30:22–25.

[3] Mamelund SE, Shelly-Egan C and Rogeberg O. The association between socioeconomic status and pandemic influenza: systematic review and meta-analysis. *medRxiv* 2020; preprint DOI: https://doi.org/10.1101/2020.12.09.20246496

[4] Mamelund SE. 1918 Pandemic morbidity: the first wave hits the poor, the second wave hits the rich. *Influenza Other Respir Viruses* 2018;12:307–313. https://doi.org/10.1111/irv.12541

[5] Janssens JP and Rieder HL. An ecological analysis of incidence of tuberculosis and *per capita* gross domestic product. *Eur Respir J* 2008;32:1415–1416.

[6] Tricco AC, Lillie E, Soobiah C, et al. Impact of H1N1 on socially disadvantaged populations: systematic review. *PLoS One* 2012;7:e39437.

[7] Zheng Z, Peng F, Xu B, et al. Risk factors of critical & mortal COVID-19 cases: a systematic literature review and meta-analysis. *J Infect* 2020:81:e16–e25.

[8] Himmels JPW, Borge TC, Brurberg KG, et al. *COVID-19: COVID-19 and risk factors for hospital admission, severe disease and death [Covid-19 og risikofaktorer for sykehusinnleggelse, alvorlig sykdom og død – en hurtigoversikt, tredje oppdatering. Hurtigoversikt 2020]*. Oslo: Norwegian Institute of Public Health, 2020.

[9] Drefahl S, Wallace M, Mussino E, et al. *Socio-demographic risk factors of COVID-19 deaths in Sweden: a nationwide register study*. Stockholm Research Reports in Demography, 2020;23. DOI: https://doi.org/10.17045/sthlmuni.12420347.v3. ISSN 2002-617X Stockholm University, Stockholm, Sweden, 2020

[10] Rostila M, Cederström A, Wallace M, et al. *Disparities in covid-19 deaths by country of birth in Stockholm, Sweden: a total population based cohort study*. Stockholm Research Reports in Demography, 2020 Preprint. https://doi.org/10.17045/sthlmuni.12852854.v1

[11] Hansson E, Albin M, Rasmussen M, et al. Stora skillnader i överdödlighet våren 2020 utifrån födelseland [Large differences in excess mortality spring 2020 according to country of birth] *Läkartidningen* 2020;117:20113.

[12] Folkhälsomyndigheten. Förekomst av covid-19 i olika yrkesgrupper. Bekräftade covid-19 fall i Sverige 13 mars–27 maj 2020. [Prevalence of covid-19 in different occupational groups. Confirmed cases in Sweden March 13 to May 27]. *Folkhälsomyndigheten* 2020; Artikelnummer 20099.

[13] Statens Serumsinstitutt. *COVID-19 og herkomst – opdateret fokusrapport [COVID-19 and country of origin. An updated focus report]*. Denmark: Statens serumsinstitutt, 2020.

[14] Magnusson K, Nygård K, Vold L, et al. Occupational risk of COVID-19 in the 1st vs. 2nd wave of infection. *medRxiv* 2020; Preprint https://www.medrxiv.org/content/10.1101/2020.10.29.20220426v1

[15] de Lusignan S, Dorward J, Jones CA, et al. Risk factors for SARS-CoV-2 among patients in the Oxford Royal College of General Practitioners Research and Surveillance Centre primary care network: a cross-sectional study. *Lancet Infect Dis* 2020;20(9):1034–1042.

[16] Williamson EJ, Walker AJ, Bhaskaran K, et al. OpenSAFELY: factors associated with COVID-19-related hospital death in the linked electronic health records of 17 million adult NHS patients. *Nature* 2020;584:430–436. DOI: 10.1038/s41586-020-2521-4. Epub 2020 Jul 8.

[17] Aldridge RW, Lewer D, Katikireddi SV, et al. Black, Asian and Minority Ethnic groups in England are at increased risk of death from COVID-19: indirect standardisation of NHS mortality data. *Wellcome Open Res* 2020;24:88. DOI: 10.12688/wellcomeopenres.15922.2. eCollection 2020

[18] Lassale C, Gaye B, Hamer M, et al. Ethnic disparities in hospitalisation for COVID-19 in England: the role of socioeconomic factors, mental health, and inflammatory and pro-inflammatory factors in a community-based cohort study. *Brain, Behav Immun* 2020;88:44–49.

[19] Raisi-Estabragh Z, McCracken C, Bethell MS, et al. Greater risk of severe COVID-19 in Black, Asian and Minority Ethnic populations is not explained by cardiometabolic, socioeconomic or behavioural factors, or by 25(OH)-vitamin D status: study of 1326 cases from the UK Biobank. *J Public Health* 2020;42:451–460.

[20] El Chaar M, King K, et al. Are African American and Hispanics disproportionately affected by COVID-19 because of higher obesity rates? *Surg Obes Relat Dis* 2020;16:1096–1099.

[21] Niedzwiedz CL, O'Donnell CA, Jani BD, et al. Ethnic and socioeconomic differences in SARS-CoV-2 infection: prospective cohort study using UK Biobank. *BMC Med* 2020;18:16.

[22] Vrålstad S and Wiggen KS. Levekår blant innvandrere i Norge 2016. [Living conditions among immigrants in Norway 2016]. Oslo-Kongsvinger, Norway: Statistics Norway, 2017.

[23] Folkehelseinstituttet. *Beredskapsregisteret for covid-19* [*Preparednessregister for covid-19*]. https://www.fhi.no/sv/smittsomme-sykdommer/corona/norsk-beredskapsregister-for-covid-19/ (accessed 28 August 2020).

[24] Atchison C, Bowman L, Vrinten C, et al. Perceptions and behavioural responses of the general public during the COVID-19 pandemic: a cross-sectional survey of UK adults. *medRxiv* 2020; Preprint https://www.medrxiv.org/content/10.1101/2020.04.01.20050039v1.full.pdf

[25] Hawkins D. Differential occupational risk for COVID-19 and other infection exposure according to race and ethnicity. *Am J Ind Med* 2020;63:817–820.

[26] Diaz E, Velando PAB and Rocas, AO. Matsikkerhet i Norge under koronapandemien. Situasjonen for innvandrere og for majoritetsbefolkningen [Food security under the COVID-19 pandemic. The situation for migrants and the majority population]. *Tidsskrift for velferdsforskning* 2020 (Submitted; abstract accepted).

[27] Sørensen K, Pelikan JM, Röthlin F, et al. Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU). *Eur J Public Health* 2015;25:1053–1058.
[28] Aradhya S, Brandén M, Drefahl S, et al. *Lack of acculturation does not explain excess COVID-19 mortality among immigrants. A population-based cohort study*. Stockholm Research Reports in Demography, 2020.
[29] Kravdal O, Alvær K, Bævre K, et al. How much of the variation in mortality across Norwegian municipalities is explained by the socio-demographic characteristics of the population. *Health Place* 2015;33:148–158.
[30] Drefahl S, Wallace M, Mussino E, et al. A population-based cohort study of socio-demographic risk factors for COVID-19 deaths in Sweden. *Nat Commun* 2020;11:5097.