Understanding the excess COVID-19 burden among immigrants in Norway

MKR Kjøllesdal[1,2], SP Juarez[3], S Aradhya[4], T Indseth[1]

[1]Norwegian Institute of Public Health, Health Services Research, 0213 Oslo, Norway
[2]Norwegian University of Life Sciences, Institute of Public Health Science, 1432 Ås, Norway
[3]Stockholm University, Department of Public Health Sciences, SE-106 91 Stockholm, Sweden
[4]Stockholm University Demography Unit (SUDA), Department of Sociology, Stockholm University, SE-106 91 Stockholm, Sweden
Address correspondence to Marte KR Kjøllesdal, E-mail: marte.k.kjollesdal@nmbu.no, makj@fhi.no

ABSTRACT

Background We aim to use intermarriage as a measure to disentangle the role of exposure to virus, susceptibility and care in differences in burden of COVID-19, by comparing rates of COVID-19 infections between immigrants married to a native and to another immigrant.
Methods Using data from the Norwegian emergency preparedness, register participants (*N*=2 312 836) were linked with their registered partner and categorized based on own and partner's country of birth. From logistic regressions, odds ratios (OR) of COVID-19 infection (15 June 2020–01 June 2021) and related hospitalization were calculated adjusted for age, sex, municipality, medical risk, occupation, household income, education and crowded housing.
Results Immigrants were at increased risk of COVID-19 and related hospitalization regardless of their partners being immigrant or not, but immigrants married to a Norwegian-born had lower risk than other immigrants. Compared with intramarried Norwegian-born, odds of COVID-19 infection was higher among persons in couples with one Norwegian-born and one immigrant from Europe/USA/Canada/Oceania (OR 1.42–1.46) or Africa/Asia/Latin-America (OR 1.91–2.01). Odds of infection among intramarried immigrants from Africa/Asia/Latin-America was 4.92. For hospitalization, the corresponding odds were slightly higher.
Conclusion Our study suggests that the excess burden of COVID-19 among immigrants is explained by differences in exposure and care rather than susceptibility.

Keywords COVID-19, infection, hospitalization, immigrant, Norway, register data

Introduction

Immigrants have been at higher risk of COVID-19 infection,[1–5] hospitalization[1,3,4,6] and mortality[1,7,8] than host country natives worldwide. Three main mechanisms to explain this have been identified: differences in exposure, underlying conditions (susceptibility) and care. Understanding the contribution of the above-mentioned mechanisms is crucial to reduce inequalities in COVID-19 or future pandemics.

Many immigrants live in socioeconomic deprivation and crowded housing and have occupations with high levels of contact with people.[2,4,5,7,9] However, several studies suggest that such factors only modestly explain the excess burden of COVID-19 experienced by immigrants.[2–4,6,10–12] Advanced age and poor health increase the risk of severe COVID-19. Immigrants are often young and healthy upon arrival in high-income countries, but health seems to deteriorate at relatively young age.[13,14] Immigrants from South Asia, the Middle East and Somalia have high prevalence of obesity, diabetes and coronary heart disease,[13–18] which could predispose them to severe forms of COVID-19.[19] However, underlying medical risk has not explained high rates of COVID-19-related hospitalizations or mortality among immigrants in previous studies.[8,11] Genetic susceptibility to COVID-19 and a severe course of the disease among groups of immigrants have also been proposed, but so far without sufficient empirical support.[20,21]

Poor host language proficiency and low familiarity with the health system are major barriers for immigrants for utilizing

Kjøllesdal MKR, PhD
SP Juarez, PhD
S Aradhya, PhD
T Indseth, Mhist

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available information and care. Qualitative studies from Norway indicate that both immigrants and service providers have experienced these challenges.[22] If immigrants have difficulties in understanding recommended control measures, preventive recommendations may lead to unintended inequalities. Furthermore, barriers to seek care when needed may worsen prognosis. Such barriers in the COVID-19 pandemic are yet to be thoroughly assessed.

A Swedish study assessed the role of language barriers and poor institutional awareness in explaining COVID-19 mortality among immigrants by examining immigrants partnered with Swedes.[21] A study design comparing rates of COVID-19 among immigrants who are married to a native and immigrants married to another immigrant is useful to disentangle some of the mechanisms possibly related to higher risk and to assess the relative importance of exposure, underlying risk and barriers. Intermarriage between immigrants and natives is both a proxy and a facilitator of integration. For an immigrant, being married to a native is related to proficiency in the host language, familiarity with the society and its institutions (including the healthcare system) and culture, and it is of importance for the creation of social networks. Language and health system knowledge would thus be a smaller barrier than among immigrants living with another immigrant. Natives married to an immigrant to a large degree share exposure with their spouses, whereas any underlying risk could still differ.

In this article, we aim to examine the extent to which the excess burden of COVID-19 among immigrants is related to differential exposure, susceptibility or care. To do so, we compare rates of notified COVID-19 cases and related hospitalizations between different constellations of own and partner's country of birth, with adjustments for sociodemographic factors (age, sex, education, household income, occupation, crowded housing) and medical risk.

Methods

Through the Norwegian emergency preparedness register,[23] data were included from the Norwegian Surveillance System for Communicable Diseases and laboratory database (all polymerase chain reaction tests with results for Severe acute respiratory syndrome coronavirus 2 (SARS-COV-2)), the Norwegian Patient Registry and Norwegian Registry for Primary Health Care (hospitalizations and medical risk groups), National Population Register (age, sex, country of birth, municipality), Statistics Norway (married/registered partner, family identifier, education, household income, crowded housing) and the Employer- and Employee Register (occupation).

The study population included persons aged ≥18 years, married or a registered partner and residing in Norway on 1 March 2020. Persons who are married or registered partners share family identifier in registries and can thus be linked to their respective partner. Other cohabiting adults do not share family identifier, cannot be linked to their partner and are thus not part of our sample. Tests for SARS-CoV-2 were included from 15 June 2020 and up to 1 June 2021.

Variables

COVID-19-related hospitalization is defined (according to national standards) as when a person has tested positive for COVID-19 and been hospitalized (inpatient) at a hospital in Norway during 2 days before or 14 days after the test.

Immigrants are defined as persons born outside Norway but residing in Norway with legal residence and categorized in two broad groups based on region of birth 'Asia, Africa and Latin America (AAL)' and 'Europe, USA, Canada and Oceania (EUCO)'. Country of birth was set to Norway if missing (N = 330 819).

Participants were categorized based on their own region of birth in combination with their partner's one: 'Intramarried Norwegian-born' (both Norwegian-born), 'Intermarried Norwegians-EUCO' (Norwegian-born married to immigrant from EUCO), 'Intermarried Norwegians-AAL' (Norwegian-born married to immigrant from EUCO), 'Intermarried EUCO' (immigrant from EUCO married to Norwegian-born), 'intramarried EUCO' (immigrant from EUCO married to another immigrant from any region), 'intermarried AAL' (immigrant from AAL married to Norwegian-born) and 'intramarried AAL' (immigrant from AAL married to an immigrant from any region). The term married was used for simplicity, but it includes all formally registered partners.

Crowded housing is defined as number of rooms in the dwelling < the number of residents (or 1 person/1 room dwelling) and/or number of square meters <25 per person. Missing values are coded in a separate category (1.7%). Highest registered level of **education** was categorized as 'Below upper secondary education', 'Upper secondary education/vocational', 'Higher education, short', 'Higher education, long' and undisclosed/no education (2.8%). We have information on education up to and including 2019. Thus, people aged ≤25 years per 1 March 2020 (0.9%) were coded into a separate category, as these not necessarily have completed their education. Information on **household income** (total registered income, allowances included, minus taxes, in 2018) was divided by the number of consumption units in the household according to the EU scale. Proportion with missing information for household income was 0.5%. Data on **occupation** and industry (2-digit) were included

(STYRK code, corresponds to ISCO-08). We did not have data on self-employed. Persons without registered occupation were coded as unemployed (32%). Fourteen **medical risk groups** were based on diagnosis codes from primary and specialist health care back to 2017 (Supplementary Table 1). A dichotomous variable was created to indicate if individuals belong to a medical risk group.

Analyses

Using logistic regressions, the odds ratio (OR) (95% confidence interval [CI]) of notified COVID-19 infection and related hospitalization were given for each category of couples, with intramarried Norwegian-born as the reference, and with the adjustments: models 1) age, sex, municipality, 2) 1+ medical risk groups, 3) 2+ occupation, household income, education and crowded housing. Model 3 is shown in a figure in addition to in table. These logistic regressions were also carried out stratified by being in a medical risk group or not. As the Norwegian, Swedish and Danish language, and also their health systems, are very similar and most people from these countries can understand information given in any of the three languages, sensitivity analyses were carried out for the logistic regression, excluding Swedes (N=25 254) and Danes (N=12 629) from the sample. We also carried out sensitivity analyses excluding all persons born in Norway to immigrant parents (N=11 782), as these persons share characteristics with both other Norwegian-born (e.g. Norwegian language proficiency and health care system knowledge) and with immigrants (e.g. social networks).

Proportions of notified COVID-19 and related hospitalizations, persons tested at least once, mean number of tests and the ratio of positive tests to total number of tests in each couple group were reported, as well as mean number of days between positive test and hospitalization.

Results

A total of 2 312 836 participants were included. The mean age was highest among intramarried Norwegian-born, and lowest among immigrants from AAL and among intramarried immigrants from EUCO (Table 1). The educational level was highest among intermarried immigrants from EUCO and intermarried Norwegian-born-EUCO. These persons together with intramarried Norwegian-born also had the highest mean household income. Intramarried immigrants from AAL had the lowest educational levels and household income, and the largest proportion living in crowded housing. Norwegian-born had highest proportions in a medical risk group.

The lowest rates of notified cases of COVID-19 (1092 per 100 000) and of related hospitalizations (66 per 100 000) were seen among intramarried Norwegian-born (Table 2). Intermarried Norwegians-EUCO had slightly higher rates of notified cases and hospitalizations, and intermarried Norwegians-AAL more than twice as high rates as intramarried Norwegian-born (Table 2). Intramarried immigrants from AAL had the highest rates of both notified cases of COVID-19 (7505 per 100 000) and related hospitalizations (663 per 100 000) (Table 2).

Adjusted for age, sex and municipality, all immigrants and intermarried Norwegians had higher odds of COVID-19 infection and of related hospitalization than intramarried Norwegian-born (Table 2). Further adjustment for medical risk, education, occupation, household income, crowded housing did not notably change the estimates, except a slight attenuation of differences in odds of hospitalization among intramarried immigrants from AAL (Table 2, Fig. 1). Compared with intramarried Norwegian-born (in fully adjusted models), the odds of COVID-19 infection was 1.4 among persons in couples with one Norwegian born and one immigrant from EUCO, about 2 for persons in couples where one partner were born in Norway and one in AAL, 2.5 among intramarried immigrants from EUCO and 4.9 among intramarried immigrants from AAL. For hospitalization, the corresponding odds were slightly higher.

Stratified on medical risk, rates of infection among those in a medical risk group was generally lower than in the total sample among Norwegian born and higher among immigrants from AAL and among intramarried immigrants from EUCO. Rates of hospitalization was as expected higher among those in a medical risk group than among others, especially among intramarried immigrants from EUCO (Table 3).

In sensitivity analyses excluding persons from Sweden and Denmark no notable changes in OR were seen (Supplementary table 2). Neither in analyses excluding Norwegian-born to immigrant parents, estimates were notably changed, except a slightly lower odds of both infection and hospitalization among Norwegian-born married to AAL-immigrants (Supplementary table 3).

The proportion of persons tested for COVID-19 at least once were just above 30%, and mean number of tests between 2.1 and 2.3 in all groups (Table 3). Days between test and hospitalization and proportion being hospitalized at or after day of COVID-19 test did not vary substantially between groups (Table 3). The proportion of positive tests was lowest among intramarried Norwegian-born, and substantially higher among intramarried AAL-immigrants than in other groups (Table 3)

Table 1 Characteristics of the study population, married/registered partner couples in Norway by own and partner's region of origin

	N	*Notified cases COVID-19 (N)*	*Hospitalization (N)*	*Mean age (years)*	*High level of education (%)**	*Above median household income (%)*	*Crowded housing (%)*	*In a medical risk group (%)*
Intramarried Norwegian-born	1 779 418	19 436	1892	54.9	38.5	53.8	5.0	25.6
Intermarried Norwegian-born EUCO	87 561	1524	137	50.9	51.8	53.5	8.4	20.5
Intermarried Norwegian-born AAL	49 272	1265	139	49.0	39.1	40.4	14.2	22.1
Intermarried EUCO-Norwegian-born	87 561	1567	130	50.0	52.5	53.6	8.5	17.6
Intramarried EUCO	139 612	5079	392	43.5	36.0	28.6	22.8	10.9
Intermarried AAL-Norwegian-born	49 272	1423	131	43.7	40.8	41.0	14.7	12.3
Intramarried AAL	120 140	9017	1141	45.5	29.9	26.6	38.8	19.7

*Higher (short)+higher (long) education. EUCO= Europe, USA, Canada or Oceania, AAL=Africa, Asia or Latin America

Discussion

Immigrants were at increased risk of COVID-19 and related hospitalization regardless of their partners being immigrant or not, but immigrants married to a Norwegian-born had lower risk than immigrants married to another immigrant. Norwegian-born married to an immigrant had higher risk than other Norwegian-born. Adjustments for medical risk, education, household income, occupation and crowded housing did not alter our results to a large extent. These findings highlight that differences in susceptibility and access to care (through poor language proficiency and system knowledge) partially explain the excess COVID-19 burden placed on immigrants. Moreover, the increased risk in both Norwegian-born and immigrants in mixed couples highlights the importance of differences in exposure through structural and social factors not accounted for in this study.

The differences between immigrant–immigrant couple and other couples were higher in Norway than previously shown in Sweden,[21] which could indicate that factors related to language barriers and poor institutional awareness might be of higher importance in a setting with low infection pressure (Norway) than a high infection pressure setting (Sweden).

Explanations

Susceptibility

The comparable odds of COVID among immigrants and Norwegian-born in mixed couples do not suggest that underlying heath risk, or genetic risk, among immigrants could explain their excess burden. Indeed, a lower proportion of immigrants than of Norwegian-born were in a medical risk group in our sample. Among intramarried immigrants from AAL, the OR of hospitalization was higher than the OR of infection compared with Norwegian-born. This could indicate an underdiagnosis of medical risk among in this group, also implying that vulnerable immigrants may not know that they are at increased risk of severe COVID-19. The proportion of immigrants considering themselves to be in a vulnerable group for COVID-19 has been shown to vary with country background.[24] Households with several generations living together are more common among immigrants than among Norwegian-born and could be one reason that elderly and vulnerable groups have not been able to keep social distance to a large degree. However, studies of secondary attach rate within households indicate that this is a phenomena but still has limited explanatory value.[25]

Barriers to care

Immigrants married to a Norwegian-born may face fewer barriers in accessing information and in navigating the system, both due to the language competency of their spouse, but also through an increased likelihood to have good proficiency in the Norwegian language themselves. The lower risk of COVID-19 in this group compared with other immigrants supports the hypothesis that language may play a role. Previous surveys in Norway suggest that immigrants generally perceive that they have access to the information they need,[24,26] but also that some information can be hard to understand.[22] Especially elderly immigrants without children nearby to help and newly arrived immigrants may have difficulties in accessing information.[26] Immigrants also report

Table 2 Rates of notified cases of COVID-19 and related hospitalizations and odds ratio (96% CI) of notified COVID-19 cases and related hospitalizations according to own and spouse's region of origin, total and by being in a medical group or not

Total

	Notified cases COVID-19			
	Per 100 000	Model 1	Model 2	Model 3
Intramarried Norwegian-born	1092	1	1	1
Intermarried Norwegian-born EUCO	1741	1.41 (1.34, 1.49)	1.41 (1.34, 1.49)	1.42 (1.34, 1.49)
Intermarried Norwegian-born AAL	2567	2.00 (1.89, 2.12)	2.00 (1.88, 2.12)	1.91 (1.80, 2.02)
Intermarried EUCO-Norwegian-born	1790	1.43 (1.36, 1.51)	1.44 (1.37, 1.52)	1.46 (1.39, 1.54)
Intramarried EUCO	3638	2.63 (2.57, 2.74)	2.66 (2.58, 2.75)	2.54 (2.46, 2.63)
Intermarried AAL-Norwegian-born	2888	2.12 (2.01, 2.45)	2.13 (2.02, 2.25)	2.01 (1.90, 2.12)
Intramarried AAL	7505	5.64 (5.49, 5.79)	5.62 (5.48, 5.77)	4.92 (4.78, 5.06)
	Hospitalizations			
	Per 100 000			
Intramarried Norwegian-born	106	1	1	1
Intermarried Norwegian-born EUCO	156	1.45 (1.22, 1.73)	1.47 (1.24, 1.75)	1.48 (1.24, 1.76)
Intermarried Norwegian-born AAL	282	2.62 (2.20, 3.12)	2.56 (2.15, 3.05)	2.42 (2.03, 2.89)
Intermarried EUCO-Norwegian-born	148	1.41 (1.18, 1.69)	1.46 (1.22, 1.74)	1.50 (1.26, 1.80)
Intramarried EUCO	280	2.94 (2.63, 3.30)	3.04 (2.72, 3.40)	2.97 (2.64, 3.33)
Intermarried AAL-Norwegian-born	266	2.88 (2.41, 3.45)	2.91 (2.43, 3.49)	2.78 (2.32, 3.34)
Intramarried AAL	950	8.96 (8.28, 9.69)	8.51 (7.86, 9.21)	7.18 (6.59, 7.83)

In a medical risk group

	Notified cases COVID-19		
	Per 100 000	Model 1	Model 3
Intramarried Norwegian-born	873	1	1
Intermarried Norwegian-born EUCO	1317	1.31 (1.15, 1.50)	1.31 (1.15, 1.50)
Intermarried Norwegian-born AAL	2509	2.32 (2.04, 2.63)	2.23 (1.96, 2.53)
Intermarried EUCO-Norwegian-born	1277	1.29 (1.11, 1.49)	1.30 (1.12, 1.50)
Intramarried EUCO	4290	3.71 (3.41, 4.05)	3.47 (3.17, 3.79)
Intermarried AAL-Norwegian-born	3079	2.56 (2.20, 2.97)	2.40 (2.06, 2.80)
Intramarried AAL	8824	7.72 (7.28, 8.18)	6.61 (6.20, 7.04)
	Hospitalizations		
	Per 100 000		
Intramarried Norwegian-born	189	1	1
Intermarried Norwegian-born EUCO	302	1.51 (1.15, 1.9)	1.49 (1.12, 1.96)
Intermarried Norwegian-born AAL	496	2.45 (1.86, 3.24)	2.40 (1.81, 3.17)
Intermarried EUCO-Norwegian-born	266	1.34 (0.98, 1.83)	1.35 (0.99, 1.85)
Intramarried EUCO	832	4.16 (2.43, 5.04)	4.04 (3.32, 4.91)
Intermarried AAL-Norwegian-born	563	2.93 (2.07, 4.15)	2.82 (1.98, 4.01)
Intramarried AAL	1896	8.46 (7.49, 9.62)	7.14 (6.22, 8.19)

Continued

Table 2 Continued

Total			
Not in a medical risk group			
	Notified cases COVID-19		
	Per 100 000	Model 1	Model 3
Intramarried Norwegian-born	1167	1	1
Intermarried Norwegian-born EUCO	1849	1.42 (1.34, 1.51)	1.43 (1.35, 1.51)
Intermarried Norwegian-born AAL	2584	1.92 (1.79, 2.05)	1.83 (1.71, 1.95)
Intermarried EUCO-Norwegian-born	1899	1.45 (1.37, 1.53)	1.48 (1.40, 1.56)
Intramarried EUCO	3558	2.52 (2.44, 2.61)	2.41 (2.33, 2.50)
Intermarried AAL-Norwegian-born	2861	2.05 (1.93, 2.18)	1.93 (1.82, 2.05)
Intramarried AAL	7183	5.17 (5.02, 5.33)	4.53 (4.39, 4.68)
	Hospitalizations		
	Per 100,000		
Intramarried Norwegian-born	78	1	1
Intermarried Norwegian-born EUCO	119	1.44 (1.15, 1.80)	1.46 (1.17, 1.83)
Intermarried Norwegian-born AAL	221	2.62 (2.09, 3.27)	2.42 (1.93, 3.04)
Intermarried EUCO-Norwegian-born	123	1.51 (1.21, 1.88)	1.58 (1.27, 1.96)
Intramarried EUCO	213	2.67 (2.33, 3.07)	2.60 (2.25, 3.00)
Intermarried AAL-Norwegian-born	224	2.88 (2.33, 3.56)	2.71 (2.19, 3.36)
Intramarried AAL	718	8.46 (7.64, 9.37)	7.11 (6.36, 7.95)

EUCO = Europe, USA, Canada or Oceania; AAL = Africa, Asia or Latin America. Adjusted for (i) sex, age, municipality, (ii) 1+ medical risk, (iii) 2+education, occupation, household income and crowded housing

to follow recommendations about social distancing and good hand hygiene as carefully as nonimmigrants.[24,27]

In Norway, close social contacts to all who test positive for COVID-19 will be contacted and imposed to quarantine and to test for COVID-19. Language barriers and lack of trust may have delayed infection tracing. Even short delays in this work can cause spread of the virus in a social network. Furthermore, knowledge about how messages about prevention of disease can be conveyed in a best possible manner to different population groups is important.

Exposure

Immigrants and Norwegian-born in mixed couples had about the same rates of COVID-19, indicating that the environment these couples share is important for the exposure and likelihood of infection. In line with previous studies,[2,11,12] socioeconomic factors we were able to adjust for could not explain differences in rates. This point toward other factors related to exposure, such as the local community infrastructure and public transport offers, which may be important to assess in future studies.

A large share of immigrants lives in larger cities where the burden of COVID-19 has been the highest. It is reasonable to assume that this will reinforce already high rates. Still, both in the current and in previous papers,[1,11] municipality have not explained much of differences in rates between immigrants and nonimmigrants. We adjusted our analyses for crowded housing. The measure is based on number of persons per square meter or room, and it can be argued that number of people in the household is more important.

Recommendations from the Norwegian authorities have been to restrict your social contact to the closest family and a few relatives or friends. For many immigrants this would mean restricting contact to others from the same country of origin. In groups having close contact with each other and less with outsiders, even a modest increase in exposure can lead to larger outbreaks of a highly communicable disease.

Transnational ties among immigrants will for many mean a relatively high perceived need for travelling abroad. Data on import of infections from travels abroad are limited but indicate that the number of imported cases has been high, especially from Asia and with strong correlation between traveler's country of birth and destination.[28] The importance of this for rates of infections is not known, but it has probably contributed to higher levels of exposure in many social networks.

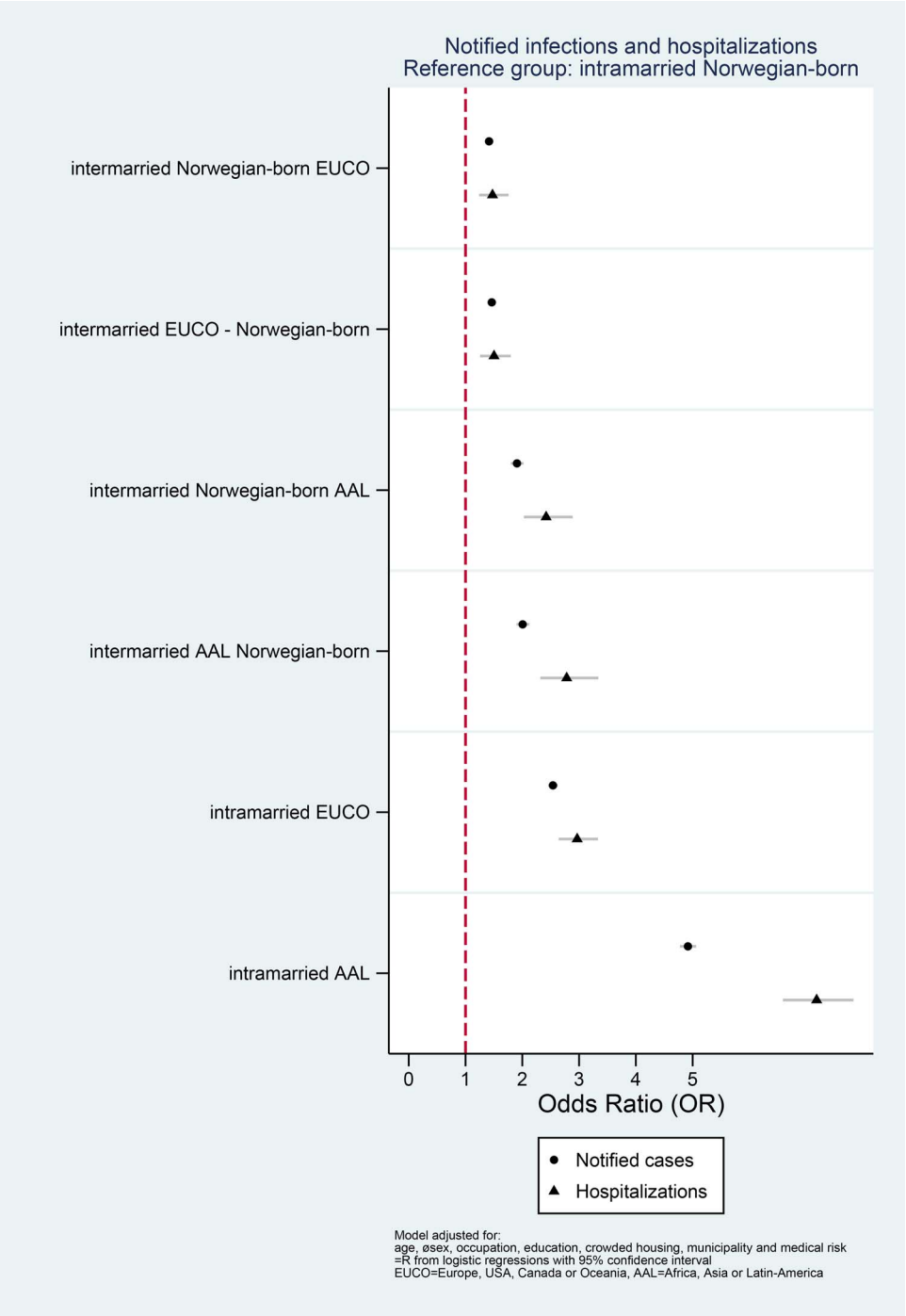

Fig. 1 OR (95% CI) of notified COVID-19 cases and related hospitalizations according to own and spouse's region of origin.

Strengths and limitation

Comprehensive register data allow us to assess rates of infection and hospitalization in a large and representative sample of the Norwegian population. We included all persons who are registered as married or cohabiting, but we were not able to identify those who live together or are in an amorous relationship without being registered as such. The latter group are probably younger and with a smaller proportion of immigrants. Marriage has been found to be a protective factor for COVID infection,[7] which could imply lower rates in our sample than in the total adult population. This is not likely to have affected our estimates much.

Table 3 Proportion tested at least once, proportion of positive tests to total tests, mean number of days between positive test and hospitalization and proportion being tested at or after hospitalization, according to own and partner's region of origin

	Proportion tested at least once	*Mean number of tests (SD)*	*Positive test/total tests (%)*	*Days between test and hospitalization (mean, SD)*	*Proportion hospitalized same day as test or earlier*
Intramarried Norwegian	31.0	2.1 (1.8)	2.7	5.9 (4.0)	15.7
Intermarried Norwegian-EUCO	32.1	2.3 (1.9)	3.7	5.2 (3.9)	23.3
Intermarried Norwegian-AAL	31.6	2.3 (1.9)	5.4	6.1 (4.2)	20.3
Intermarried EUCO-Norwegian	32.2	2.3 (2.0)	3.7	6.1 (4.1)	12.3
Intramarried EUCO	30.8	2.2 (2.0)	8.2	4.9 (3.9)	22.5
Intermarried AAL-Norwegian	31.5	2.3 (2.1)	6.3	5.6 (3.8)	17.4
Intramarried AAL	31.8	2.3 (2.1)	15.3	5.6 (3.8)	16.0

EUCO= Europe, USA, Canada or Oceania; AAL = Africa, Asia or Latin America

Immigrants choosing to marry a Norwegian probably vary from other with the same country background in several ways which we are not able to observe, and these differences are probably not the same for immigrants from AAL and from EUCO. Norwegian-born in this study includes persons born in Norway to immigrant parents. Rates of COVID-19 among Norwegian-born to immigrant parents have shown to be quite comparable to rates among immigrants from their parents' country of birth.[29] In some groups by country of birth, a notable proportion of mixed couples may be Norwegian-born to immigrant parents having married an immigrant. In the total sample, this proportion is rather low. Our sensitivity analyses indicate that the importance of this for our results is small (Supplementary Table 3).

The large proportion of positive among immigrants and intermarried Norwegians, and especially among immigrants from AAL and intramarried EUCO immigrants, suggest that the differences in rates between intramarried Norwegians and others are even larger than shown in this study.

Conclusion

The excess burden of COVID-19 among immigrants was not explained either by differences in susceptibility or by differences in exposure related to indicators of social disadvantage. Our results pointed toward some importance of barriers to care, although this could not fully explain differences in infection rates between immigrants and Norwegian-born. Similar rates of COVID-19 within mixed couples point toward the importance of social, cultural and structural factors not accounted for in this study. Efforts to reduce inequalities in health, including during pandemics, need to be prolonged work to identify and alter such determinants of health.

Declarations

Ethics approval and consent to participate

The study was approved by the Norwegian Regional Ethics Committee South-East (REK 19864). The study is based on national register data and includes a large number of Norwegian citizens, and therefore consent from participants was not possible to collect. Thus, the Norwegian Regional Ethics Committee South-East waived the need for consent. The Norwegian Regional Ethics Committees are authorized by Norwegian law**.** All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable

Availability of data and materials

The Beredt C19 Register is a national emergency preparedness register established to monitor Covid-19 infections and the use of health services in Norway during the Covid-19 pandemic, which was established by the Norwegian Institute of Public Health. For confidentiality reasons, authors are not allowed to share the data. Only workers at the Norwegian Institute of Public Health are allowed to access the data.

Competing interest

The authors declare no conflict of interest; no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work

Role of the funder

The funding sources had no influence on the design or conduct of the study, the collection, management, analysis, or interpretation of the data, the preparation, review, or approval of the manuscript, or the decision to submit the manuscript for publication

Authors' contributions

SPJ and SA conceived the idea for the analytical approach to the topic, MKRK did the statistical analyses and drafted the article, all authors contributed in the final stage of writing and in critically reviewing the manuscript.

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