Socio-economic and Demographic Risk Factors in COVID-19

Hospitalization among Migrants and Ethnic Minorities

Sabrina Islamoska¹, PhD (0000-0002-7693-6142), Jørgen Holm Petersen¹, PhD (0000-0003-3979-7443), Thomas Benfield²,³, MD (0000-0003-0698-9385), Marie Norredam¹,², PhD (0000-0002-0899-317X)

¹ Danish Research Centre for Migration, Ethnicity and Health, Section of Health Services Research, Department of Public Health, University of Copenhagen, Øster Farimagsgade 5, 1014 Copenhagen, Denmark

² Department of Infectious Diseases, Copenhagen University Hospital - Amager and Hvidovre, Hvidovre, Denmark

³ Institute of Clinical Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark

Correspondence to: Sabrina Islamoska, Department of Public Health, University of Copenhagen, Øster Farimagsgade 5, 1014 Copenhagen, Denmark
Tel.: +45 3533 6070. E-mail: saim@sund.ku.dk

Word count: 3271
Number of tables: 4
ABSTRACT

Background: Migrants and ethnic minorities have been shown to be at increased risk of hospitalization from COVID-19, our aim was to analyze the contribution of socioeconomic and demographic risk factors on hospital admissions for COVID-19 among migrants and ethnic minorities compared to the majority population.

Methods: We used nationwide register data on all hospitalized COVID-19 cases between February and June 2020 (n = 2232) and random controls from the general population (n = 498117). We performed logistic regression analyses, adjusting for age, sex, comorbidity, and socioeconomic and demographic factors. Main outcome measure was Hospitalization with COVID-19. Odds ratios (OR) and 95% confidence intervals (95% CI) are estimated by using logistic regression analyses, adjusting for age, sex, comorbidity, and socioeconomic and demographic factors.

Results: Among 2232 COVID-19 cases, the OR of hospitalization with COVID-19 among immigrants and descendants of Non-Western origin was 2.5 times higher (95% CI: 2.23 to 2.89) than that of the majority population, with most pronounced results among individuals from Iraq, Morocco, Pakistan, and Somalia. The OR was largely attributed to comorbidity and socioeconomic factors, especially household size, occupation, and population density.

Conclusion: There is a significantly higher OR of hospitalization with COVID-19 among Non-Western migrants and ethnic minorities compared with ethnic Danes. This knowledge is crucial for health policymakers and practitioners in both the current and future pandemics to identify more vulnerable groups and target prevention initiatives.

Keywords: COVID-19; Ethnic Groups; Socioeconomic Factors
INTRODUCTION

Migrants and ethnic minorities are reported to be at increased risk of acquiring COVID-19 and to have worse clinical outcomes of COVID-19 compared with the majority population.\textsuperscript{1-5} National statistics from Denmark and other Scandinavian countries correspondingly show that the incidence of COVID-19 cases is higher among individuals of non-Western origin, particularly of Middle Eastern origin, compared with individuals of Danish and other Western origin.\textsuperscript{6,7} In 2020, individuals of non-Western origin made up 58\% of migrants in Denmark and among descendants, 83\% were of non-Western origin.\textsuperscript{8} Therefore, the focus of this study is on individuals of non-Western origin, as they make up the majority of migrants and have a higher incidence of COVID-19 than individuals of Western origin.

Research on previous pandemics, including the 1918 Influenza and the 2009 A/H1N1 Influenza, likewise shows migrants and ethnic minorities as disproportionately affected compared with majority populations.\textsuperscript{9,10} This is hypothetically explained by various factors related to socio-economy, language barriers, cultural norms, and comorbidity, in combination with poorer access to healthcare.\textsuperscript{9-11} First, lower income among migrants and ethnic minorities may result in more people living together in closer proximity: data from Denmark show that the proportion of COVID-19 cases of Non-Western origin more often live $\geq5$ individuals at the same address compared with ethnic Danes and individuals of Western origin.\textsuperscript{6} Furthermore, some migrant and ethnic minority groups may have a culture of multi-generational living, which challenges social distancing and exposes older individuals with comorbidities at higher risk of COVID-19.\textsuperscript{11} In addition, multi-generational living may as well be a function of socioeconomic disadvantages besides being a cultural phenomenon\textsuperscript{12}. Second, many migrants and ethnic minorities are more vulnerable to cardiovascular disease, diabetes, and hypertension, all associated with more severe COVID-19.\textsuperscript{11,13-15} Third, compared to ethnic Danes, individuals of Non-Western origin are more likely to work
‘frontline’ jobs within e.g. transportation, hospitality, cleaning and operational services, and social welfare institutions; these jobs typically preclude working from home and are associated with a higher prevalence of COVID-19 across populations. Finally, language barriers may account for higher vulnerability among migrants and ethnic minorities if, for instance, guidelines on COVID-19 from the national and regional health authorities are not adequately translated and communicated. These associations all make migrants and ethnic minorities more vulnerable to COVID-19. Some of these associations have already been documented in reports and scientific papers from England and the United States. However, further studies are needed from other European immigration countries, which have different compositions of migrants and ethnic minorities as well other contextual factors at play. Furthermore, adults of non-Western origin have a higher morbidity, but a lower mortality compared with individuals of Danish origin. Yet, no national health initiatives have been implemented in order to promote the health status of individuals of non-Western origin. Moreover, large-scale register-based studies are needed to disentangle the contribution of socioeconomic, demographic, and comorbidity factors on COVID-19 hospitalization. Therefore, the aim of this study is to analyse the contribution of different socioeconomic and demographic risk factors, including job status, income, education, household size, and population density, on hospitalizations for COVID-19 among migrants and ethnic minorities compared to the majority population.

METHODS

Study population

The study population is based on individuals residing in Denmark aged > 17 years on January 1st 2020. Cases are identified by being registered as inpatients (admitted for ≥ 24 hours) with a
COVID-19 diagnosis of B34.2, B34.2A, B97.2, or B97.2A according to the 10th version of International Classification of Diseases (ICD-10) registered between February 1st 2020 and June 30th 2020 (n = 2547). COVID-19 cases are defined as being diagnosed with COVID-19 as the primary reason for hospital admission. Controls are formed by a random control sample of 500000 individuals in the general population aged > 17 years. Individuals who do not have information on sex or birthdate or are aged < 18 years (n = 81), have a COVID-19 diagnosis as the secondary reason for hospital contact (n = 308), or have negative values of equivalised disposable income (n = 1522) are excluded, and COVID-19 cases identified in the random controls sample are recoded as cases instead of controls (n = 287). The final study population consists of 500349 individuals including 2232 cases and 498117 controls (Figure 1, Supplementary material).

Covariates

Country of birth

The study population is categorized using country of birth (Danish/Immigrant), or mother’s country of birth (Descendant) as a proxy hereof, to define individuals’ ethnicity. Ethnicity is defined in three ways as: 1) origin categorized as Danish (a person of Danish origin has at least one parent, who is a Danish citizen born in Denmark), immigrant (an immigrant is born in a foreign country and none of the parents are Danish citizens born in Denmark) or descendant (a descendant is born in Denmark and none of the parents are Danish citizens born in Denmark); 2) grouped country of birth categorized as Danish (Denmark), Western (all EU countries, Andorra, Australia, Canada, Iceland, Liechtenstein, Monaco, New Zealand, Norway, San Marino, Switzerland, USA or the Vatican) and Non-Western (Albania, Bosnia and Herzegovina, Belarus, Kosovo, North Macedonia, Moldova, Montenegro, Russia, Serbia, the Soviet Union, Turkey, Ukraine, former Yugoslavia, all countries in Africa, South- and Central America, Asia, Oceania with the exception of Australia and New
Zealand, or stateless); and 3) seven specific countries of birth, where a minimum of ten COVID-19 cases are identified to compare with individuals born in Denmark (Denmark, Iraq, Lebanon, Morocco, Pakistan, Somalia, Turkey, or former Yugoslavia). Information on country of birth is obtained from Statistics Denmark. For the descriptive analyses, immigrants and descendants are separated, and for the regression analyses, immigrants and descendants are considered as one group. Individuals are categorized into Western and Non-Western countries of birth without distinguishing between being immigrant or descendant. The length of residence is also included for immigrants as a proxy for integration with a range from 0 to 34 years of residence and was categorized as ≤ 5; 6-15; 16-29; ≥ 30 years.

COVID-19

National register-based hospital data on cases of COVID-19 are obtained from The National Patient Register, which includes information on diagnoses whenever an individual is in contact with any hospital department by inpatient, outpatient, or emergency room visits. Data are obtained on all individuals registered with the following ICD-10 COVID-19 diagnoses: coronavirus infection, unspecified site (ICD-10: B34.2; B34.2A), or coronavirus as the cause of diseases classified to other chapters (ICD-10: B97.2, B97.2A). To increase the validity of COVID-19 diagnoses, COVID-19 cases are defined as inpatients hospitalized for at least 24 hours and only with COVID-19 as the primary reason for hospitalization.

Socioeconomic and demographic factors

Data on socioeconomic and demographic factors are obtained from Statistics Denmark. The covariates include: i) marital status: unmarried vs married; ii) highest-attained educational level
based on International Standard Classification of Education (ISCED):\textsuperscript{23} low (primary school; ISCED levels: 0-2); medium (upper secondary education, business high school, vocational education; ISCED levels: 3-4); and high (short-term further education, middle-range education, bachelor’s, extended education, research degree; ISCED levels: 5-8); iii) persons per household: range: 1 to ≥ 5 persons; iv) occupation defined by either business industry or occupational status for those who are unemployed or with unknown business industry: 1) business industry: farming, forestry and fishery; manufacture, raw material extraction and supply company; building and construction; trade and transportation; information and communication; financing and insurance; property trading and rental service; business service; public administration, education and health and social services; culture, leisure and other services; and 2) employed with unknown business industry (self-employed, collaborating spouse, salary earner); other occupational inactivity (retired persons, other economically inactive persons who have no predominant income and welfare benefits are lower than the basic amount); and unemployed (unemployed person, unemployment benefit claimant, welfare claimant); v) equivalised disposable income level based on household per year in Danish Kroner (DKK) divided into quartiles (Q1: ≤178,169 DKK, Q2: 178,170-246,364 DKK, Q3: 246,365-334,495 DKK, Q4: >334,495 DKK); and vi) population density calculated by number of total individuals in a province divided by area in km\textsuperscript{2} ranging from 60 to 4340 persons/km\textsuperscript{2} and categorized based on quartiles into: < 83 persons/km\textsuperscript{2}, 83 to 310 persons/km\textsuperscript{2}, ≥ 310 persons/km\textsuperscript{2}.

\textit{Comorbidity}

To understand the contribution of comorbidity on the OR of COVID-19 hospitalization among migrants and ethnic minorities compared to the majority population, information is obtained on all
ICD-10 diagnoses from The National Patient Register registered between 1980 and 2020. Comorbidities are weighted by the Charlson Comorbidity Index (CCI) to create a continuous weighted comorbidity score. The comorbidity scores assign weights from 1-6 to each comorbidity for every individual, which then receives a sum of weights based on all present comorbidities in an individual. A comorbidity score of 0 represents no comorbidities; higher scores indicate more severe comorbidities. The CCI is categorized into a score of: 0, 1, 2, or ≥ 3.

**Statistical analyses**

Descriptive analyses was conducted to investigate the distribution of comorbidity, socioeconomic and demographic factors among individuals with and without COVID-19.

For the main analyses, logistic regression models were used to calculate odds ratios (OR) of COVID-19 hospitalization and 95% confidence intervals (95% CI) among different ethnic groups. Different categorizations of ethnic groups were used to investigate whether the OR of hospitalization with COVID-19 differed depending on the definition of ethnicity. First, the OR of hospitalization with COVID-19 was investigated among individuals of immigrants and descendants, Western origin, Non-Western origin, and residence length of immigrants compared with individuals of Danish origin. Nine models were applied to adjust for several covariates, including age, sex, CCI, household size, occupation, population density, equivalised disposable income, and educational level. Further, based on the ethnic groups who were most frequently hospitalized with COVID-19, the OR of hospitalization with COVID-19 was investigated among individuals of specific ethnic origins compared with Danish origin. In sensitivity analyses, it was investigated whether individuals of Non-Western origin, compared with individuals of Danish origin, were at higher risk of hospitalization with COVID-19 by including interaction terms between origin and...
either occupational group (farming, forestry, fishery, manufacture, raw material extraction and supply company; Business service; Trade and transportation; Public administration, education and social and health services; Other occupational inactivity; Unemployed) or household size (1 to ≥5 persons) respectively. In additional analyses, the OR of hospitalization with COVID-19 was investigated for different risk factors presented as unadjusted and adjusted OR estimates.

SAS Enterprise Guide version 7.1 is used to conduct all analyses including a statistical significance level of 0.05. The study is approved by the University of Copenhagen Ethics Board, reference number 514-0231/18-3000. Individual consent is not required by Danish legislation for register-based studies.

RESULTS

In this national register-based study, 2232 individuals are hospitalized due to COVID-19 in Denmark between February and June 2020. Table 1 shows the descriptive analyses. The median age at hospitalization with COVID-19 is 67 years with an overall equal distribution of men and women. More than 80% of hospitalized COVID-19 cases are of Danish origin. Yet, a higher number of COVID-19 cases per 10000 persons are of Non-Western origin or other origins than Danish. Out of the 2232 COVID-19 cases, 13 individuals (0.6%) are from the Nordic countries Finland, Norway and Sweden. Among immigrants, there is a higher number of COVID-19 cases where the individual’s length of residence exceeds 30 years. Having a higher CCI shows a higher number of COVID-19 cases per 10000 persons. The COVID-19 cases are not observed specifically in some business industries, but a higher proportion of COVID-19 cases is occupationally inactive, thus, either retired or economically inactive. There is also a higher number of COVID-19 cases in the provinces around Copenhagen.
The results of the main analyses (Table 2) show that among all immigrants and descendants compared with Danes, there is a 13% higher OR of hospitalization with COVID-19 adjusting for sex, a 79% higher OR (95% CI: 1.56 to 2.01) adjusting for age, and a 37% higher OR (95% CI: 1.19 to 1.56) adjusting further for CCI and all socioeconomic and demographic factors.

Among individuals of Western origin compared with individuals of Danish origin, there is a 46% lower OR of hospitalization with COVID-19 (95% CI: 0.42 to 0.70) adjusting for sex, which changed to a 21% lower OR (95% CI: 0.62 to 1.02) adjusting for age, and a 33% lower OR (95% CI: 0.51 to 0.88) adjusting for CCI and socioeconomic and demographic factors. Compared with individuals of Danish origin, individuals of Non-Western origin have a 49% higher OR of hospitalization with COVID-19 (95% CI: 1.31 to 1.69) adjusting for sex, a 2.54 times higher OR (95% CI: 2.23 to 2.89) adjusting for age, and an 87% higher OR (95% CI: 1.60 to 2.17) adjusting for CCI and all socioeconomic and demographic factors.

The results of the analyses for specific countries show that the OR of hospitalization with COVID-19 was highest among individuals from Somalia, followed by Morocco, Iraq, Pakistan, Lebanon, Turkey, and former Yugoslavia.

Overall, the results of the analyses on immigrants’ residence length show that when comparing with immigrants who lived in Denmark for +30 years, the risk of COVID-19 hospitalization is lowest among immigrants who lived in Denmark ≤ 5 years, while the risk is higher among immigrants who lived in Denmark for 16–29 years. However, the results were not statistically significant for immigrants, who lived in Denmark between 16–29 years.

For the sensitivity analyses, specific groups of business industries or occupational activity are selected based on having prevalent COVID-19 cases among individuals of Non-Western origin, and the analyses are grouped by these occupational groups using individuals of Danish origin as
reference group (Table 3). The results show that for all occupational groups, individuals of Non-Western origin have a higher OR of hospitalization with COVID-19 in a range of ORs from 1.27 to 3.01 compared with individuals of Danish origin. In the analyses for household size, the OR of hospitalization with COVID-19 is investigated in individuals of Non-Western origin compared with individuals of Danish origin (Table 3). Among individuals of Non-Western, the ORs of hospitalization with COVID-19 were observed to be 1.52 to 2.37 times higher compared with individuals of Danish origin.

In the adjusted analyses where different risk factors are investigated separately in relation to the OR of hospitalization with COVID-19 (Table 4), the highest OR’s are observed in individuals of Non-Western origin; the older age groups; those with higher CCI; those living five or more individuals together in one household; those working within public administration, education, and health and social services; and those who are occupationally inactive.

**DISCUSSION**

Using an exceptional nationwide cohort, findings of this study provide unique information on the contribution of socioeconomic and demographic factors to the higher COVID-19 hospitalization risk among migrants and ethnic minorities compared to ethnic Danes. Immigrants and descendants of Non-Western origin have a 2.5 times higher OR of hospitalization. About half of the excess risk is explained by comorbidity, socioeconomic and demographic factors.

This study complements emerging evidence from other European countries that migrants and ethnic minorities are at higher risk of hospitalization for COVID-19. The higher risk of COVID-19 hospitalization should be seen in the context of the higher positive incidence and mortality rates for COVID-19 among migrants and ethnic minorities in Denmark and other European countries.
Interestingly, existing literature shows that ethnic disparities in COVID-19 incidence, mortality, and hospitalizations seem to cut across European countries with different compositions of migrant and ethnic minority populations, ranging from the UK and France, with many minorities originating from former colonies, to ‘new’ immigration countries like the Nordics, where labour migrants, refugee populations, and family-reunified individuals comprise the vast proportion of Non-Western migrants.28 This pattern indicates that cross-cutting factors related to socioeconomic vulnerability are at stake. First, ethnic minorities may live together in larger households facilitating transmission and impeding isolation, possibly due to socioeconomic deprivation and cultural factors as multigenerational living. Data from Denmark observe that more families of Non-Western origin live in households of fewer m² per person in general, which also applies for those with a COVID-19 infection.29,30 In our study, about 50% of the hospitalized COVID-19 cases who live ≥ 5 persons per household are of Danish origin, while 40% are of non-Western origin and the minority are of Western origin. Thus, cases of COVID-19 infections and hospitalizations respectively shows different patterns in terms of ethnicity and household size, as we did not observe a dose-response relation between ORs and household size. Second, COVID-19 hospitalization among ethnic minorities seem to be related with occupational groups, where working from home is not a possibility, as observed in other research.31 Third, population density is an important factor to hospitalization risk, which is supported by a Swedish study where neighbourhood population density together with income, employment, and household members explained COVID-19 mortality risk.32 Finally, education and income do not markedly change the estimates, which could be because occupation, population density and household size work as a proxy hereof. As comorbidity, socioeconomic, and demographic factors explain only explain some of the risk, it can only be speculated about the remaining contributory factors. Some explanations could be language barriers,33 ‘newness’,34 limited health literacy,35 and genetic and biological susceptibility,36 which
may be driving mechanisms potentially interacting in complex, dynamic ways within groups of migrants and ethnic minorities. The complex interplay between factors related to language barriers, health literacy, access in healthcare, migration background and changing migration patterns may as well explain why immigrants with shorter residence length are at lower risk of COVID-19 hospitalization, which was against our expectations, as residence length was considered a proxy for integration over the years.

The key strength of this study is its basis on unique nationwide data representing all hospitalized COVID-19 cases in Denmark from February to June 2020. Using national data made it possible to include a large study population and a random reference group, link different national registers and utilize retrospective and recent data on several comorbidity, socioeconomic and demographic confounders and link them to each individual. The validity of COVID-19 diagnoses is increased by only including cases where COVID-19 is the primary reason for hospital contact.

This study also has several limitations. First, Denmark’s management of the pandemic through restrictive policies resulted in a comparatively limited number of hospitalizations during the ‘first wave’ limiting the sample size of specific country groups and reducing statistical power in some analyses. Second, adjusting for CCI does not markedly change the results, yet, another Danish study finds an increased risk of COVID-19 among individuals with one or more comorbidities of the CCI. However, using a comorbidity index constructed specifically for COVID-19 could be more relevant. Third, the study is limited by the availability of data of the basis for residence permit, and missing data on business industry and educational level. Fourth, the study population only includes the most severe COVID-19 cases hospitalized for \( \geq 24 \) hours and is not representative of COVID-19 cases in the general population. Therefore, the findings of this study only apply to the most severe COVID-19 cases among migrants and ethnic minorities.
In conclusion, there is a higher OR of hospitalization with COVID-19 among migrants originating from Non-Western countries compared to ethnic Danes. The excess risk is explained by socioeconomic and demographic factors. Further studies including qualitative approaches are needed to understand the underlying reasons for the observed disparities. The results also highlight migrants and ethnic minorities as more vulnerable groups in terms of acquiring COVID-19, and that this tendency should be investigated among COVID-19 cases in the general population as well. This knowledge is crucial for health policymakers and practitioners in both the current and future pandemics to identify more vulnerable groups and target prevention initiatives.

**FUNDING**

This study was funded by University Hospital Hvidovre, University of Copenhagen and Statens Serum Institut.

**CONFLICT OF INTEREST**

TB reports grants from Novo Nordisk Foundation, from Simonsen Foundation, from Lundbeck Foundation, from Pfizer, from Gilead, from Kai Hansen Foundation and from Erik and Susanna Olesen’s Charitable Fund, and personal fees from GSK, from Pfizer, from Boehringer Ingelheim, from Gilead, from MSD, and from Pentabase, outside the submitted work. All other authors declare no competing interests.

**KEY-POINTS**

- Findings of this study show that immigrants and descendants of Non-Western origin had a 2.5 times higher OR of hospitalization with COVID-19.
- The excess risk is explained by comorbidity as well as socioeconomic and demographic factors, especially household size, occupation, and population density.

- This knowledge is crucial for health policymakers and practitioners in both the current and future pandemics to identify more vulnerable groups and target prevention initiatives.

DATA AVAILABILITY STATEMENT

The data underlying this article cannot be shared publicly, as the data are only available to researchers of this article based on individual data approval from Statistics Denmark.
REFERENCES

1. Pan D, Sze S, Minhas J, et al. The impact of ethnicity on clinical outcomes in COVID-19: A systematic review. EClinicalMedicine 2020;23.
2. Diaz E, Norredam M, Aradhya S, et al. Situational brief: Migration and COVID-19 in Scandinavian countries. 2020.
3. Singh I, Chand K, Singh A, Kandadi K. Time for a culture change: understanding and reducing risk, morbidity and mortality from COVID-19 in those of black and minority ethnicity. British Journal of Hospital Medicine 2020;81:1-4.
4. Raisi-Estabragh Z, McCracken C, Bethell M, 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 (Oxf) 2020;42:451-460.
5. Sze S, Pan D, Nevill C, et al. Ethnicity and clinical outcomes in COVID-19: A systematic review and meta-analysis. EClinicalMedicine 2020;29.
6. Statens Serum Institut. COVID-19 i Danmark - Epidemiologisk trend og fokus: Herkomst (etnicitet). Copenhagen, Denmark; 2020.
7. Indseth T, Grøsland M, Arnesen T, et al. Covid-19 among immigrants in Norway; notified infections, related hospitalizations and associated deaths. A register based study. Scand J Public Health 2020;Submitted.
8. Statistics Denmark. Indvandrere i Danmark 2020. 2020. Report No.: 978-87-501-2370-5.
9. Mertz D, Kim T, Johnstone J, et al. Populations at risk for severe or complicated influenza illness: systematic review and meta-analysis. BMJ : British Medical Journal 2013;347:f5061.
10. Krishnan L, Ogunwole S, Cooper L. Historical Insights on Coronavirus Disease 2019 (COVID-19), the 1918 Influenza Pandemic, and Racial Disparities: Illuminating a Path Forward. Annals of internal medicine 2020;173:474-481.
11. Abuelgasim E, Saw L, Shirke M, Zeinah M, Harky A. COVID-19: Unique public health issues facing Black, Asian and minority ethnic communities. Current Problems in Cardiology 2020;45:100621.
12. Mikolai J, Keenan K, Kulu H. Intersecting household-level health and socio-economic vulnerabilities and the COVID-19 crisis: An analysis from the UK. SSM - Population Health 2020;12:100628.
13. Andersen G, Kamper-Jørgensen Z, Carstensen B, Norredam M, Bygbjerg I, Jørgensen M. Diabetes among migrants in Denmark: Incidence, mortality, and prevalence based on a longitudinal register study of the entire Danish population. Diabetes Res Clin Pract 2016;122:9-16.
14. Carlsson A, Wändell P, Hedlund E, et al. Country of birth-specific and gender differences in prevalence of diabetes in Sweden. Diabetes Research and Clinical Practice 2013;100:404-408.
15. Koochek A, Mirmiran P, Azizi T, et al. Is migration to Sweden associated with increased prevalence of risk factors for cardiovascular disease? European Journal of Cardiovascular Prevention & Rehabilitation 2008;15:78-82.
16. Statistics Denmark. Indvandrere i Danmark 2019. Copenhagen, Denmark; 2019.
17. Loweree J, Reichlin-Melnick A, Ewing W. The Impact of COVID-19 on Noncitizens and Across the U.S. Immigration System. USA; 2020.
18. Jervelund S, Malik S, Ahlmark N, Villadsen S, Nielsen A, Vitus K. Morbidity, Self-Perceived Health and Mortality Among non-Western Immigrants and Their Descendants in Denmark in a Life Phase Perspective. Journal of Immigrant and Minority Health 2017;19:448-476.
19. Statistics Denmark: https://www.dst.dk/da/Statistik/emner/befolkning-og-valg/indvandrere-og-efterkommere/indvandrere-og-efterkommere Accessed 24-11 2020.
Statistics Denmark. Documentation of statistics for The Population 2020. Copenhagen, Denmark; 2020.

Lynge E, Sandegaard J, Rebolj M. The Danish National Patient Register. Scandinavian Journal of Public Health 2011;39:30-33.

World Health Organization. International Statistical Classification of Diseases and Related Health Problems 10th Revision. World Health Organization, 2016.

Eurostat Statistics Explained: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_Standard_Classification_of_Education_(ISCED)#Implementation_of_ISCED_2011._28levels_of_education.29 Accessed 27-May 2021.

Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali W. New ICD-10 version of the Charlson comorbidity index predicted in-hospital mortality. Journal of Clinical Epidemiology 2004;57:1288-1294.

Charlson M, Pompei P, Ales K, MacKenzie C. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. Journal of Chronic Diseases 1987;40:373-383.

Giorgi Rossi P, Marino M, Formisano D, et al. Characteristics and outcomes of a cohort of COVID-19 patients in the Province of Reggio Emilia, Italy. PLOS ONE 2020;15:e0238281.

Lassale C, Gaye B, Hamer M, Gale C, Batty G. Ethnic Disparities in Hospitalization for COVID-19: a Community-Based Cohort Study in the UK. medRxiv 2020:2020.2005.2019.20106344.

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;11:5097-5097.

Institut for Menneskerettigheder. Corona rammer skævt - Etnicitet og smitte. 2020.

Statens Serum Institut. COVID-19 og herkomst – opdateret fokusrapport. Copenhagen, Denmark; 2020.

Kuhlmann E, Falkenbach M, Klasa K, Pavolini E, Ungureanu M. Migrant carers in Europe in times of COVID-19: a call to action for European health workforce governance and a public health approach. European Journal of Public Health 2020;30:iv22-iv27.

Rostila M, Cederström A, Wallace M, Brandén M, Malmberg B, Andersson G. Disparities in covid-19 deaths by country of birth in Stockholm, Sweden: A total population based cohort study. 2020.

Karrebæk M, Helleshøj Sørensen S: https://www.languageonthemove.com/covid-19-exposes-language-and-migration-tensions-in-denmark/ Accessed 01-Dec 2020.

Nørredam M. Migration and health: exploring the role of migrant status through register-based studies. Dan Med J 2015;62:B5068.

Svendsen M, Bak C, Sørensen K, et al. Associations of health literacy with socioeconomic position, health risk behavior, and health status: a large national population-based survey among Danish adults. BMC Public Health 2020;20:565.

El-Khatib Z, Jacobs G, Ikomey G, Neogi U. The disproportionate effect of COVID-19 mortality on ethnic minorities: Genetics or health inequalities? EClinicalMedicine 2020;23:100430.

Christensen D, Strange J, Gislason G, et al. Charlson Comorbidity Index Score and Risk of Severe Outcome and Death in Danish COVID-19 Patients. Journal of General Internal Medicine 2020;35:2801-2803.
Table 1. Baseline characteristics of COVID-19 cases in the study population (N = 500349) and percentage of the Danish adult population (N = 4671587).

| Characteristics | No., (%) | No. | No. |
|-----------------|----------|-----|-----|
| **Hospitalized COVID-19 cases in Denmark, N = 2232** |          |     |     |
| Age group, no. (%) | N = 500349 |          |     |     |
| < 30 years | 114 (5%) | 91083 | 1 |
| 30-39 years | 140 (6%) | 74213 | 1 |
| 40-49 years | 265 (12%) | 79475 | 3 |
| 50-59 years | 336 (15%) | 86086 | 3 |
| 60-69 years | 359 (16%) | 72212 | 4 |
| ≥ 70 years | 1018 (46%) | 97280 | 9 |
| **Total in study population, N = 500349** | 1 | 1 | 1 |
| **No. of hospitalized COVID-19 cases per 10,000 personsa, N = 4671587** | 2232 | 4671587 | 1 |
| **Sex, no. (%) | N = 500349 |  |  |  |
| Women | 1027 (46%) | 253755 | 3 |
| **Origin, no. (%) | N = 500349 |  |  |  |
| Danish | 1893 (85%) | 431646 | 4 |
| Immigrant | 313 (14%) | 59801 | 4 |
| Descendant | 26 (1%) | 8902 | 2 |
| **Grouped country of birth, no. (%) | N = 500349 |  |  |  |
| Danish | 1893 (85%) | 431646 | 4 |
| Westernb | 63 (3%) | 26270 | 2 |
| Non-Western | 276 (12%) | 42433 | 6 |
| Immigrant | 253 (92%) | 34736 | 6 |
| Descendant | 23 (8%) | 7697 | 2 |
| **Country of birth, no. (%) | N = 448001 |  |  |  |
| Denmark | 1893 (92%) | 431646 | 4 |
| Iraq | 35 (2%) | 2678 | 12 |
| Lebanon | 13 (1%) | 2163 | 5 |
| Morocco | 21 (1%) | 971 | 20 |
| Pakistan | 30 (1%) | 2134 | 13 |
| Somalia | 23 (1%) | 1387 | 15 |
| Turkey | 35 (2%) | 5697 | 5 |
| Yugoslavia | 11 (0.5%) | 1325 | 7 |
| **Length of residence for immigrants, no. (%) | N = 59801 |  |  |  |
| ≤ 5 years | 22 (7%) | 19849 | 1 |
| 6-15 years | 42 (13%) | 13283 | 2 |
| 16-29 years | 104 (33%) | 15592 | 6 |
| ≥ 30+ years | 145 (46%) | 11077 | 12 |
| Marital status, no. (%) | Unmarried | 1053 (47%) | 270235 | 3 |
|------------------------|-----------|------------|--------|---|
| N = 500349             |           |            |        |   |

| Educational level, no. (%) | Low       | 619 (28%) | 121030 | 4 |
|---------------------------|-----------|-----------|--------|---|
| N = 493820                | Medium    | 864 (40%) | 206914 | 3 |
|                           | High      | 692 (32%) | 164384 | 3 |

| Charlson Comorbidity Index, no. (%) | 0          | 1330 (62%) | 434589 | 2 |
|-------------------------------------|------------|------------|--------|---|
| N = 500349                          | 1          | 317 (15%)  | 30589  | 9 |
|                                     | 2          | 259 (12%)  | 22584  | 10 |
|                                     | ≥ 3        | 247 (11%)  | 12508  | 18 |

| No. of persons per household, no. (%) | 1 person  | 715 (32%) | 113212 | 5 |
|--------------------------------------|-----------|-----------|--------|---|
| N = 500349                           | 2 persons | 895 (40%) | 188842 | 4 |
|                                      | 3 persons | 245 (11%) | 77918  | 2 |
|                                      | 4 persons | 210 (9%)  | 74819  | 2 |
|                                      | ≥ 5 persons| 167 (7%)  | 45558  | 3 |

| Occupation, no. (%) | Unemployed | 32 (1%) | 9992 | 2 |
|---------------------|------------|--------|------|---|
| N = 496819          | Employed without known business industry | 46 (2%) | 9427 | 4 |
|                     | Other occupational inactivity | 1050 (47%) | 120252 | 8 |
|                     | Farming, forestry, fishery, manufacture, raw material extraction and supply company | 108 (5%) | 46183 | 2 |
|                     | Building and construction | 58 (3%) | 20227 | 2 |
|                     | Trade and transportation | 209 (9%) | 85982 | 2 |
|                     | Information and communication | 46 (2%) | 13584 | 3 |
|                     | Financing and insurance | 34 (1%) | 10158 | 3 |
|                     | Property trading and rental services | 21 (1%) | 5744 | 3 |
|                     | Business service | 130 (6%) | 41984 | 2 |
|                     | Public administration, education and health and social services | 453 (20%) | 116694 | 3 |
|                     | Culture, leisure and other services | 42 (2%) | 17381 | 2 |

| Province, no (%), N = 500349 | Copenhagen city (PD = 4340 persons/km²) | 513 (23%) | 66553 | 7 |
|-------------------------------|------------------------------------------|-----------|--------|---|
|                               | Copenhagen area (PD = 1602 persons/km²)  | 335 (15%) | 34699  | 9 |
|                               | North Zealand (PD = 320 persons/km²)     | 348 (16%) | 49825  | 6 |
|                               | East Zealand (PD = 310)                  | 103 (4%)  | 21671  | 4 |
| persons/km² | West- and South Zealand (PD = 91 persons/km²) | 290 (13%) | 49518 | 5 |
|------------|---------------------------------------------|----------|-------|---|
|            | Funen (PD = 143 persons/km²)                | 103 (4%) | 43077 | 2 |
|            | North Jutland (PD = 75 persons/km²)         | 124 (6%) | 53037 | 2 |
|            | East Jutland (PD = 154 persons/km²)         | 101 (4%) | 77786 | 1 |
|            | West Jutland (PD = 60 persons/km²)          | 152 (7%) | 37032 | 3 |
|            | South Jutland (PD = 82 persons/km²)         | 153 (7%) | 63483 | 2 |
|            | Bornholm (PD = 67 persons/km²)              | 10 (1%)  | 3668  | 2 |

Income, no (%), N = 500349

| Income, no (%) | 1st quartile (≤178,169 DKK) | 2nd quartile (178,170-246,364 DKK) | 3rd quartile (246,365-334,495 DKK) | 4th quartile (>334,495 DKK) |
|----------------|------------------------------|-----------------------------------|-----------------------------------|-----------------------------|
|                | 594 (27%)                    | 594 (27%)                         | 457 (20%)                         | 587 (26%)                   |
|                | 128540                       | 123904                           | 123945                            | 123960                      |
|                | 4                            | 4                                | 3                                 | 4                           |

Note.

a The number of hospitalized COVID-19 cases per 10,000 persons in the Danish population. Example: Among women, there are 3 hospitalized COVID-19 cases per 10000 persons in the Danishpopulation. Weight is calculated by: (COVID-19 cases/Total number of individuals in respective group)/10.7)*100.

b There are too few COVID-19 cases to be displayed among immigrants and descendants of Western origin.

c There are 6529 individuals without information on educational level.

d There are 139671 individuals without information on business industry, but with information on occupational status (Unemployed/Employed without known business industry/Other occupational inactivity) and 3530 individuals without information on neither business industry or occupational status.

e Business industries of farming, forestry, fishery and manufacture, raw material extraction and supply company are combined into one group due to few cases in some industries.

f PD: population density.
Table 2. Odds ratio (OR) with 95% confidence intervals (95% CI) of hospitalization with COVID-19 among individuals grouped by regional origin, immigrants and descendants, and specific countries of birth living in Denmark, N = 500349.

| Group                          | No. of individuals | COVID-19 cases | Crude OR (95% CI) | Sex OR (95% CI) | + Age OR (95% CI) | + CCI OR (95% CI) | + Household size OR (95% CI) | + Population density OR (95% CI) | + Income OR (95% CI) | + Occupation OR (95% CI) | + Educational level OR (95% CI) |
|-------------------------------|--------------------|----------------|-------------------|-----------------|------------------|-------------------|-----------------------------|-----------------------------|----------------------|---------------------|-----------------------------|
| Danish origin (ref.)          | 431646             | 1893           | 1.00              | 1.00            | 1.00             | 1.00              | 1.00                        | 1.00                        | 1.00                 | 1.00                | 1.00                        |
| Immigrants and descendants    | 68703              | 339            | 1.13 (1.00-1.26)  | 1.13 (1.00-1.26)| 1.79 (1.56-2.01) | 1.76 (1.55-1.98) | 1.65 (1.46-1.87)           | 1.35 (1.19-1.53)            | 1.36 (1.19-1.54)     | 1.39 (1.22-1.59)     | 1.37 (1.19-1.56)     |
| Danish origin (ref.)          | 431646             | 1893           | 1.00              | 1.00            | 1.00             | 1.00              | 1.00                        | 1.00                        | 1.00                 | 1.00                | 1.00                        |
| Western origin                | 26270              | 63             | 0.55 (0.43-0.70)  | 0.54 (0.42-0.70) | 0.79 (0.62-1.02) | 0.80 (0.62-1.03) | 0.78 (0.60-1.01)           | 0.67 (0.52-0.86)           | 0.67 (0.52-0.87)     | 0.68 (0.52-0.88)     | 0.67 (0.51-0.88)     |
| Non-Western origin            | 42433              | 276            | 1.49 (1.31-1.69)  | 1.49 (1.31-1.69)| 2.54 (2.23-2.89) | 2.44 (2.14-2.79) | 2.28 (1.99-2.61)           | 1.81 (1.58-2.08)           | 1.85 (1.60-2.14)     | 1.91 (1.65-2.21)     | 1.87 (1.60-2.17)     |
| Denmark (ref.)                | 431646             | 1893           | 1.00              | 1.00            | 1.00             | 1.00              | 1.00                        | 1.00                        | 1.00                 | 1.00                | 1.00                        |
| Iraq                          | 2678               | 35             | 3.01 (2.15-4.21)  | 2.97 (2.12-4.16)| 4.79 (3.41-6.73) | 4.77 (3.38-6.73) | 4.44 (3.14-5.00)           | 3.52 (2.49-5.00)           | 3.62 (2.54-5.15)     | 3.77 (2.64-5.37)     | 3.61 (2.45-5.33)     |
| Lebanon                       | 2163               | 13             | 1.37 (0.79-2.37)  | 1.36 (0.79-2.35)| 2.48 (1.43-4.29) | 2.49 (1.44-4.32) | 2.32 (1.34-4.03)           | 2.07 (1.19-3.59)           | 2.13 (1.22-3.71)     | 2.18 (1.25-3.81)     | 2.20 (1.23-3.92)     |
| Morocco                       | 971                | 21             | 5.02 (3.25-7.75)  | 5.00 (3.24-7.73)| 7.63 (4.92-11.84)| 7.58 (4.88-11.78)| 7.17 (4.61-11.15)          | 4.53 (2.91-7.06)           | 4.69 (2.99-7.34)     | 4.76 (3.04-7.46)     | 3.70 (2.19-6.26)     |
| Pakistan                      | 2134               | 30             | 3.24 (2.25-4.66)  | 3.21 (2.23-4.62)| 5.06 (3.51-7.29) | 4.70 (3.25-6.79) | 4.19 (2.88-6.10)           | 2.50 (1.72-3.65)           | 2.58 (1.76-3.78)     | 2.68 (1.83-3.93)     | 2.81 (1.90-4.14)     |
| Somalia                       | 1387               | 23             | 3.83 (2.53-5.80)  | 3.81 (2.52-5.77)| 7.24 (4.76-11.01)| 6.45 (4.16-10.00)| 5.92 (3.80-9.21)           | 5.36 (3.44-8.36)           | 5.50 (3.51-8.62)     | 5.88 (3.74-9.25)     | 5.88 (3.62-9.57)     |
| Turkey                        | 5697               | 35             | 1.40 (1.00-1.90)  | 1.40 (1.00-1.90)| 2.33 (1.66-3.27) | 2.28 (1.63-3.21) | 2.12 (1.51-3.01)           | 1.55 (1.10-2.20)           | 1.61 (1.14-2.19)     | 1.65 (1.16-2.13)     | 1.63 (1.13-2.17)     |
| Residence length | 1325 | 11  | 1.90 (1.05-3.45) | 1.90 (1.05-3.45) | 2.45 (1.35-4.45) | 1.92 (0.99-3.72) | 1.81 (0.93-3.50) | 1.27 (0.66-2.46) | 1.30 (0.67-2.53) | 1.33 (0.68-2.58) | 1.44 (0.74-2.79) |
|------------------|------|-----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Former Yugoslavia* | 11077 | 145 | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            |
| Residence length | 15592 | 104 |
| +30 years (ref.) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Residence length | 13283 | 42  | 0.51 (0.39-0.65) | 0.51 (0.40-0.66) | 0.93 (0.70-1.23) | 0.94 (0.70-1.25) | 0.89 (0.67-1.19) | 1.04 (0.78-1.40) | 1.03 (0.76-1.38) | 1.02 (0.76-1.38) | 1.18 (0.85-1.64) |
| 16-29 years      |      |     | 0.24 (0.17-0.34) | 0.24 (0.17-0.34) | 0.63 (0.42-0.94) | 0.66 (0.44-1.00) | 0.65 (0.43-0.98) | 0.80 (0.53-1.22) | 0.80 (0.53-1.21) | 0.85 (0.56-1.30) | 0.88 (0.55-1.40) |
| Residence length | 19849 | 22  | 0.08 (0.05-0.13) | 0.08 (0.05-0.13) | 0.28 (0.17-0.47) | 0.31 (0.18-0.52) | 0.31 (0.18-0.52) | 0.38 (0.22-0.64) | 0.36 (0.21-0.61) | 0.36 (0.21-0.74) | 0.36 (0.19-0.70) |
| 6-15 years       |      |     | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            |
| Residence length | <5 years |      | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            | 0.00            |

Note. * The analyses on specific countries of birth are based on 448001 individuals. **The analyses on immigrants’ residence length are based on 59801 individuals.
Table 3. Odds ratio (OR) with 95% confidence intervals (95% CI) of hospitalization with COVID-19 among individuals of Non-Western origin compared with Danish origin grouped by specific occupational groups in Denmark with prevalent COVID-19 cases and by number of persons in households.

| Origin and occupation, N = 399980 | No. of individuals | COVID-19 cases | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) |
|-----------------------------------|--------------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Danish origin (ref.)              | 361489             | 1671           | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| Non-Western origin                |                    |                |             |             |             |             |             |             |             |             |
| Farming and manufacture \*        | 3310               | 17             | 2.27 (1.35-3.82) | 2.30 (1.37-3.87) | 3.38 (2.00-5.69) | 3.48 (2.06-5.87) | 3.28 (1.94-5.54) | 2.88 (1.71-4.87) | 2.89 (1.71-4.90) | 3.01 (1.77-5.09) |
| Business service                  | 5337               | 22             | 1.34 (0.85-2.13) | 1.38 (0.87-2.19) | 1.86 (1.17-2.95) | 1.72 (1.07-2.76) | 1.62 (1.01-2.59) | 1.34 (0.83-2.17) | 1.35 (0.84-2.20) | 1.27 (0.77-2.09) |
| Trade and transportation          | 9507               | 43             | 1.95 (1.40-2.74) | 1.91 (1.36-2.67) | 2.56 (1.83-3.60) | 2.55 (1.81-3.59) | 2.35 (1.66-2.51) | 1.78 (1.26-2.51) | 1.77 (1.25-2.51) | 1.77 (1.24-2.53) |
| Public administration, education and social and health services | 7283               | 57             | 2.14 (1.62-2.83) | 2.16 (1.63-2.85) | 3.00 (2.26-3.97) | 2.96 (2.23-3.93) | 2.80 (2.11-3.72) | 2.19 (1.65-2.91) | 2.19 (1.65-2.92) | 2.20 (1.65-2.94) |
| Other occupational inactivity     | 8170               | 98             | 1.39 (1.12-1.71) | 1.39 (1.12-1.71) | 2.72 (2.19-3.37) | 2.62 (2.10-3.27) | 2.50 (2.00-3.13) | 1.92 (1.53-2.40) | 1.88 (1.49-2.36) | 1.82 (1.42-2.33) |
| Unemployed                        | 2958               | 18             | 3.44 (1.66-7.16) | 3.56 (1.71-7.40) | 3.87 (1.38-5.97) | 3.57 (1.65-7.76) | 3.30 (1.52-6.41) | 2.95 (1.35-6.39) | 2.93 (1.35-6.39) | 2.30 (0.95-5.59) |

Table 4. Odds ratio (OR) with 95% confidence intervals (95% CI) of hospitalization with COVID-19 among individuals of Non-Western origin compared with Danish origin grouped by number of persons in households, N = 474079

| Origin and number of persons in households, N = 474079 | No. of individuals | COVID-19 cases | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) |
|-------------------------------------------------------|--------------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Danish origin (ref.)                                  | 431646             | 1893           | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| Non-Western origin | 42157 | 276 |
|--------------------|-------|-----|
| 1 person           | 5141  | 37  |
|                    | 1.14 (0.81-1.58) | 1.11 (0.80-1.55) |
| 2 persons          | 9608  | 69  |
|                    | 1.51 (1.18-1.93) | 1.52 (1.19-1.95) |
| 3 persons          | 8578  | 60  |
|                    | 2.51 (1.87-3.36) | 2.52 (1.88-3.38) |
| 4 persons          | 8308  | 43  |
|                    | 1.98 (1.42-2.78) | 2.00 (1.43-2.80) |
| ≥5 persons         | 10522 | 67  |
|                    | 2.15 (1.57-2.95) | 2.15 (1.57-2.95) |

Note. *Farming, forestry, fishery, manufacture, raw material extraction and supply company are abbreviated as Farming and manufacture due to limited space in this table.*
Table 4. Unadjusted and adjusted odds ratio (OR) with 95% confidence intervals (95% CI) of hospitalization with COVID-19 by risk factor, N = 500349.

| Risk factor                  | No. of individuals | COVID-19 cases | OR (95% CI) Unadjusted N= 500349 | OR (95% CI) Adjusted  
|------------------------------|--------------------|----------------|-----------------------------------|------------------------|
| **Grouped country of birth** |                    |                |                                   |                        |
| Danish                       | 431646             | 1893           | 1.00                              | 1.00                   |
| Western                      | 26270              | 63             | 0.55 (0.43-0.70)                  | 0.66 (0.50-0.87)       |
| Non-Western                  | 42433              | 276            | 1.49 (1.31-1.69)                  | 1.80 (1.55-2.10)       |
| **Sex**                      |                    |                |                                   |                        |
| Men                          | 246594             | 1205           | 1.00                              | 1.00                   |
| Women                        | 253755             | 1027           | 0.83 (0.76-0.90)                  | 0.75 (0.68-0.82)       |
| **Age groups**               |                    |                |                                   |                        |
| < 30 years                   | 91083              | 114            | 1.00                              | 1.00                   |
| 30-39 years                  | 74213              | 140            | 1.51 (1.18-1.93)                  | 1.39 (1.08-1.80)       |
| 40-49 years                  | 79475              | 265            | 2.67 (2.14-3.33)                  | 2.40 (1.91-3.03)       |
| 50-59 years                  | 86086              | 336            | 3.13 (2.53-3.87)                  | 2.70 (2.16-3.38)       |
| 60-69 years                  | 72212              | 359            | 3.99 (3.23-4.92)                  | 3.15 (2.50-3.97)       |
| ≥ 70 years                   | 97280              | 1018           | 8.44 (6.95-10.24)                 | 5.58 (4.40-7.07)       |
| **Charlson Comorbidity Index** |                    |                |                                   |                        |
| 0                            | 434589             | 1330           | 1.00                              | 1.00                   |
| 1                            | 30589              | 317            | 3.41 (3.02-3.86)                  | 2.33 (2.04-2.65)       |
| 2                            | 22584              | 259            | 3.78 (3.31-4.32)                  | 2.30 (2.00-2.65)       |
| ≥ 3                          | 12508              | 247            | 6.56 (5.72-7.53)                  | 3.67 (3.17-4.25)       |
| Household size | 1 person | 113212 | 715 | 1.00 | 1.00 |
|----------------|----------|--------|-----|------|------|
| 2 persons      | 188842   | 895    | 0.75 (0.68-0.83) | 0.84 (0.76-0.94) |
| 3 persons      | 77918    | 245    | 0.50 (0.43-0.57) | 0.96 (0.81-1.13) |
| 4 persons      | 74819    | 210    | 0.44 (0.38-0.52) | 0.97 (0.81-1.17) |
| ≥ 5 persons    | 45558    | 167    | 0.58 (0.49-0.69) | 1.12 (0.92-1.37) |
| Population density | > 300 km² | 170381 | 494 | 1.00 | 1.00 |
|                | 83-310 km² | 157220 | 439 | 0.38 (0.35-0.43) | 0.37 (0.33-0.41) |
|                | < 83 km² | 172748 | 1299 | 0.37 (0.33-0.41) | 0.36 (0.32-0.40) |
| Income         | 1st quartile (≤178,169 DKK) | 128540 | 594 | 0.98 (0.87-1.09) | 0.84 (0.73-0.97) |
|                | 2nd quartile (178,170-246,364 DKK) | 123904 | 594 | 1.01 (0.90-1.14) | 0.79 (0.69-0.90) |
|                | 3rd quartile (246,365-334,495 DKK) | 123945 | 457 | 0.78 (0.69-0.88) | 0.80 (0.70-0.91) |
|                | 4th quartile (>334,495 DKK) | 123960 | 587 | 1.00 | 1.00 |
| Occupation     | Unemployed | 9992 | 32 | 1.00 | 1.00 |
|                | Employed | 9427 | 46 | 1.53 (0.97-2.40) | 1.66 (0.97-2.83) |
|                | Other occupational inactivity | 120252 | 1050 | 2.74 (1.93-3.90) | 2.03 (1.29-3.18) |
|                | Farming, forestry, fishery, manufacture, raw material extraction and supply company* | 46067 | 108 | 0.73 (0.49-1.09) | 1.40 (0.87-2.26) |
|                | Building and construction | 20160 | 58 | 0.90 (0.58-1.38) | 1.60 (0.96-2.68) |
|                | Trade and transportation | 85759 | 209 | 0.76 (0.52-1.10) | 1.42 (0.90-2.25) |
|                | Information and communication | 13556 | 46 | 1.06 (0.67-1.67) | 1.49 (0.87-2.54) |
|                | Financing and insurance | 10130 | 34 | 1.05 (0.65-1.70) | 1.44 (0.83-2.52) |
| Activity                                           | Value   | N | Lower CI | Upper CI |
|---------------------------------------------------|---------|---|----------|----------|
| Property trading and rental services              | 5730    | 21| 1.15 (0.66-1.99) | 1.42 (0.76-2.64) |
| Business service                                  | 41874   | 130| 0.97 (0.66-1.43) | 1.55 (0.97-2.49) |
| Public administration, education and health and social services | 116530  | 453| 1.22 (0.85-1.74) | 2.17 (1.38-3.40) |
| Culture, leisure and other services               | 17342   | 42 | 0.76 (0.48-1.20) | 1.27 (0.74-2.16) |
| **Education**                                     |         |   |          |          |
| Lower level                                       | 121030  | 619| 1.22 (1.09-1.36) | 1.09 (0.96-1.23) |
| Medium level                                      | 206914  | 864| 0.99 (0.90-1.10) | 1.02 (0.92-1.14) |
| Higher level                                      | 164384  | 692| 1.00      | 1.00      |

Note: *Adjusted for sex, age, CCI, household size, occupation, population density, income and educational level.*