Severe COVID-19 in people 55 and older during the first year of the pandemic in Sweden

JIM Original Article

doi: 10.1111/joim.13522

Severe COVID-19 in people 55 and older during the first year of the pandemic in Sweden

Annika Rosengren[1,2], Christina E. Lundberg[1], Mia Söderberg[3], Ailiana Santosa[1,4], Jon Edqvist[1], Martin Lindgren[1,2], Maria Åberg[4,5], Magnus Gisslén[6,7], Josefina Robertson[4,6,7], Ottmar Cronie[4], Naveed Sattar[1,8], Jesper Lagergren[9,10], Maria Brandén[11,12], Jonas Björk[13,14] & Martin Adiels[4]

From the [1]Department of Molecular and Clinical Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden; [2]Region Västra Götaland, Department of Medicine, Geriatrics and Emergency Medicine, Sahlgrenska University Hospital Östra Hospital, Gothenburg, Sweden; [3]Occupational and Environmental Medicine, School of Public Health and Community Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden; [4]School of Public Health and Community Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden; [5]Region Västra Götaland, Regionhälsan, Gothenburg, Sweden; [6]Region Västra Götaland, Sahlgrenska University Hospital, Gothenburg, Sweden; [7]Department of Infectious Diseases, Institute of Biomedicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden; [8]Institute of Cardiovascular and Medical Sciences, University of Glasgow, Glasgow, UK; [9]Upper Gastrointestinal Surgery, Department of Molecular Medicine and Surgery, Karolinska Institutet, Karolinska University Hospital, Stockholm, Sweden; [10]School of Cancer and Pharmaceutical Sciences, King's College London, London, UK; [11]Stockholm University Demography Unit (SUDA), Department of Sociology, Stockholm University, Stockholm, Sweden; [12]Institute for Analytical Sociology (IAS), Linköping University, Norrköping, Sweden; [13]Division of Occupational and Environmental Medicine, Lund University, Lund, Sweden; and [14]Clinical Studies Sweden, Forum South, Skåne University Hospital, Lund, Sweden

Abstract. Rosengren A, Lundberg CE, Söderberg M, Santosa A, Edqvist J, Lindgren M, et al. Severe COVID-19 in people 55 and older during the first year of the pandemic in Sweden. *J Intern Med.* 2022;**292**:641–653.

Background. Exposure to many contacts is the main risk factor for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, while risk of serious disease and death is chiefly determined by old age and comorbidities. Relative and population-attributable fractions (PAFs) of multiple medical and social exposures for COVID-19 outcomes have not been evaluated among older adults.

Objectives. We describe the effect of multiple exposures on the odds of testing positive for the virus and of severe disease (hospital care or death) and PAFs in Swedish citizens aged 55 years and above.

Methods. We used national registers to follow all citizens aged 55 years and above with respect to (1) testing positive, (2) hospitalization, and (3) death between 31 January 2020 and 1 February 2021.

Results. Of 3,410,241 persons, 156,017 (4.6%, mean age 68.3 years) tested positive for SARS-CoV-2, while 35,999 (1.1%, mean age 76.7 years) were hospitalized or died (12,384 deaths, 0.4%, mean age 84.0 years). Among the total cohort, the proportion living without home care or long-term care was 98.8% among persons aged 55–64 and 22.1% of those aged 95 and above. After multiple adjustment, home care and long-term care were associated with odds ratios of 7.9 (95% confidence interval [CI] 6.8–9.1) and 22.5 (95% CI 19.6–25.7) for mortality, with PAFs of 21.9% (95% CI 20.9–22.9) and 33.3% (95% CI 32.4–34.3), respectively.

Conclusion. Among Swedish residents aged 55 years and above, those with home care or long-term care had markedly increased risk for COVID-19 death during the first year of the pandemic, with over 50% of deaths attributable to these factors.

Keywords: comorbidity, COVID-19, demographics, mortality, population study, severe illness

Introduction

For most people infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the clinical course is relatively mild, but in a proportion symptoms progress to serious pulmonary and other complications, usually within 10–14 days. Clinical presentation can be different among the very old and frail compared to that among younger persons, with more rapid progression to death. These cases

may never reach or be considered for hospital care.

While the risk of being infected with SARS-CoV-2 is directly linked to risk of exposure, serious complications and death are predominantly linked to old age, male sex, frailty, and comorbidities [1–6]. Comparable to Europe as a whole [7], only a minority of all COVID-19 deaths in Sweden have been in people of working age where risk of being infected and of subsequent severe disease or death varies with exposure at work [8–11], and other demographic and socioeconomic factors [11, 12]. Given the increased risk of serious illness and death, older persons in Sweden and elsewhere were advised to avoid face-to-face contact from the outset of the pandemic [13]. Still, many older adults depend on other people for their daily living and could not avoid being exposed to infection while also being frail, often with multiple comorbid conditions.

The high risk of death from COVID-19 in residential or long-term care is well known [1, 14–16], though there is limited information about the risk associated with home care [14]. Prior studies have shown that excess mortality was higher among those receiving either home care or long-term care compared with older persons living independently. However, these studies did not consider comorbidities or consider the potential magnitude of the effect at the population level.

All Swedish individuals have a unique personal identification number (PIN) that makes it possible to combine data from several registers with detailed records on multiple health and social issues. The present study used register data on all Swedish citizens aged 55–110 years and alive on 1 January 2020. We sought to estimate absolute, relative, and population-attributable fractions (PAFs) of testing positive for SARS-CoV-2, being hospitalized, and death associated with COVID-19 in relation to age, sex, comorbid conditions, home care or long-term care, and demographics during the first year of the pandemic.

Materials and methods

Data sources

Data for the study population were assembled through a multilinkage of several nationwide administrative and health care registers (appendix pp. 2–3).

Study population, definitions, and outcomes

The study population comprised all persons registered as living in Sweden aged 55 years and older, alive on 1 January 2020 (41% of the Swedish population aged ≥18). A limited number of individuals (<0.5%) with conflicting information (mostly because of reused PINs) were excluded. Baseline comorbidities and outcomes were based on hospital diagnoses, defined as shown in detail in Tables S1 and S2. The Charlson Comorbidity Index (CCI) for register-based research was calculated as previously described [17] with modifications according to data availability (defined in Table S3). Information on municipal care for the elderly or disabled was categorized into independent living, home care only, and long-term care (living in a long-term care facility).

Statistics Sweden provided demographics data from the last update in 2019. The country of origin was dichotomized as follows: those born in a Nordic country (Sweden, Denmark, Finland, Iceland, or Norway) or any other country. Additional variables included housing (meter square per habitant, number of people per household); residing in an urban, suburban, or rural area; population density of the residential area; annual income divided by the number of members in the household; and education defined as compulsory only (≤9 years), 10–12 years, or college/university education. The Swedish National Board of Health and Welfare provided data on health, home care, and living in a long-term care facility (appendix pp. 2–3).

The outcomes were (1) infection with COVID-19 based on a positive polymerase chain reaction (PCR) test, (2) severe COVID-19 defined as any hospitalization or death with a diagnosis of COVID-19 (International Classification of Diseases [ICD] 10 codes U071 and U072), and (3) death with a COVID-19 diagnosis as an underlying or contributory cause of death. To determine death from COVID-19, the underlying cause had to be related to symptoms, pre-existing conditions, or complications associated with COVID-19 (Table S4). We used a prespecified algorithm to exclude hospitalizations and deaths due to other causes, where a diagnosis of COVID-19 was considered to be incidental (Table S2). Of the 30,468 hospitalizations, 29,097 (95.5%) had COVID-19 as a principal diagnosis. Among the 12,384 deaths, 12,011 (97.0%) had COVID-19 as an underlying cause (Table S4), with acceptable underlying or

Table 1. *COVID-19 in all Swedish citizens aged 55 years and older in January 2020, total infected, deaths, hospitalized, and treated in intensive care units, by age, until 1 February 2021*

	Total population	Age				
		55–64	65–74	75–84	85–94	95–110
Population	3,410,241	1,225,692	1,107,726	768,931	275,296	32596
Total COVID-19 cases						
Cases (%)	156,017 (4.6)	78,855 (6.4)	32,991 (3.0)	23,320 (3.0)	17,544 (6.4)	3307 (10.1)
Hospitalized[a] (%)	30,468 (0.9)	6992 (0.6)	7381 (0.7)	9055 (1.2)	6254 (2.3)	786 (2.4)
ICU[b] (%)	3664 (0.1)	1307 (0.1)	1445 (0.1)	827 (0.1)	83 (0.0)	2 (0.0)
Severe COVID-19[c]	35,999 (1.1)	7069 (0.6)	7710 (0.7)	10,503 (1.4)	9054 (3.3)	1663 (5.1)
Deaths (%)	12,384 (0.4)	423 (0.04)	1404 (0.1)	3956 (0.5)	5313 (1.9)	1288 (4.0)
Case fatality						
Case fatality, overall	7.9	0.5	4.3	17.0	30.3	38.9
Case fatality, period 2[d]	5.3	0.3	2.7	13.0	25.9	33.7
Hospital case fatality	6853 (22.5)	346 (4.9)	1075 (14.6)	2508 (27.7)	2513 (40.2)	411 (52.3)
ICU case fatality	1179 (32.2)	213 (16.3)	512 (35.4)	405 (49.0)	47 (56.6)	2 (100.0)
Location of death with COVID-19						
At home	485 (3.9)	42 (9.9)	59 (4.2)	126 (3.2)	188 (3.5)	70 (5.4)
At a long-term care facility	5139 (41.5)	17 (4.0)	254 (18.1)	1332 (33.7)	2708 (51.0)	828 (64.3)
In hospital	6438 (52.0)	352 (83.2)	1042 (74.2)	2389 (60.4)	2297 (43.2)	358 (27.8)
Other	322 (2.6)	12 (2.8)	49 (3.5)	109 (2.8)	120 (2.3)	32 (2.5)

Note: Data are *n* (%).
Abbreviation: ICU, intensive care unit.
[a]With an acceptable main diagnosis. The list of acceptable main diagnoses is presented in Table S2.
[b]ICU is reported as the main diagnosis only.
[c]Severe COVID-19: hospitalization or death.
[d]Case fatality rate is calculated during period 2 (1 October 2020 to 1 February 2021).

principal diagnoses, such as symptoms compatible with COVID-19 including pneumonia, pulmonary embolism, or respiratory or kidney failure (Table S2). For 1371 hospitalizations and 189 deaths with a COVID-19 code, the underlying or principal diagnosis supported that COVID-19 was not the cause but incidental (e.g., bone fracture, appendicitis, or cancer death); these cases were not included as outcomes. We included both in-hospital and out-of-hospital deaths. The date of diagnosis was defined in the following order: date of COVID-19-hospitalization (for hospitalized patients), date of first positive test, and date of COVID-19 death. All cases registered between 31 January 2020 and 1 February 2021 were included.

Case fatality rates (CFRs) were calculated as the ratio of deaths divided by cases. Because few PCR tests were carried out during the first wave in the spring, an unknown number of symptomatic cases could not be identified. During the second wave, from 1 October 2020 to 1 February 2021—when testing of all suspected cases was recommended—we were able to estimate CFRs based on the number of deaths divided by cases.

All data were linked, after which personal identifiers were removed and replaced by a code. The project was approved by the Swedish Ethical Review Authority. Because pseudonymized data were used, consent was not applicable.

Statistical methods. All major events, severe COVID-19, and COVID-19 deaths were recorded up to 1 February 2021, with comorbidities and demographics recorded until 1 January 2020, to avoid bias due to added reporting during the pandemic.

In baseline tables, data are reported without imputation (Tables 1 and 2, Tables S5–S9). Missing information on need of care is labelled as independent living, whereas other missing data were imputed using Multivariate Imputation by Chained Equations [18] with five imputed datasets. Except

Table 2. *Participant characteristics stratified by COVID infection and severity*

		By COVID-19 infection			
	Total population	Non COVID-19 population	Any COVID-19[a]	Severe COVID-19[b]	Death from COVID-19
Number of individuals	3,410,241	3,254,224 (95.5)	156,017 (4.6)	35,999 (1.1)	12,384 (0.4)
Sociodemographic (Jan 2020)					
Age (years), mean (standard deviation)	69.7 (10.1)	69.8 (10.0)	68.3 (11.6)	76.7 (11.6)	84.0 (9.0)
Age group					
55–64	1,225,692 (35.9)	1,146,837 (35.2)	78,855 (50.5)	7069 (19.6)	423 (3.4)
65–74	1,107,726 (32.5)	1,074,735 (33.0)	32,991 (21.1)	7710 (21.4)	1404 (11.3)
75–84	768,931 (22.5)	745,611 (22.9)	23,320 (14.9)	10,503 (29.2)	3956 (31.9)
85–94	275,296 (8.1)	257,752 (7.9)	17,544 (11.2)	9054 (25.2)	5313 (42.9)
95 and above	32,596 (1.0)	29,289 (0.9)	3307 (2.1)	1663 (4.6)	1288 (10.4)
Sex (male)	1,640,491 (48.1)	1,566,417 (48.1)	74,074 (47.5)	19,965 (55.5)	6620 (53.5)
Nordic origin[c]					
No	383,889 (11.3)	355,825 (10.9)	28,064 (18.0)	7293 (20.3)	1252 (10.1)
Yes	2,869,527 (84.1)	2,754,412 (84.6)	115,115 (73.8)	22,207 (61.7)	6809 (55.0)
Residence					
Population density (*n*/ 100,000)	3.0 (5.7)	2.9 (5.6)	3.7 (6.3)	4.4 (6.7)	4.0 (6.2)
Urban	2,423,987 (71.5)	2,301,612 (71.2)	122,375 (78.6)	29,565 (82.3)	10,277 (83.1)
Rural	649,962 (19.2)	629,064 (19.5)	20,898 (13.4)	3758 (10.5)	1123 (9.1)
Suburban	315,092 (9.3)	302,634 (9.4)	12,458 (8.0)	2595 (7.2)	964 (7.8)
Living arrangements					
Area per habitant (m^2)	58.3 (29.0)	58.6 (29.0)	52.4 (26.9)	52.8 (27.8)	52.4 (28.3)
Number of habitants	2.0 (1.1)	1.9 (1.1)	2.20 (1.5)	1.9 (1.5)	1.6 (1.5)
Income per habitant	2.5 (5.8)	2.5 (5.7)	2.61 (6.9)	2.1 (2.7)	1.9 (2.8)
Household type					
Independent living	3,125,906 (91.7)	2,998,279 (92.1)	127,627 (81.8)	22,113 (61.4)	3934 (31.8)
Home care	184,866 (5.4)	170,552 (5.2)	14,314 (9.2)	8010 (22.3)	3694 (29.8)
Long-term care	99,469 (2.9)	85,393 (2.6)	14,076 (9.0)	5876 (16.3)	4756 (38.4)
Education[d]					
≤9 years	820,275 (24.1)	783,678 (24.1)	36,597 (23.5)	13,058 (36.3)	5403 (43.6)
10–12 years	1,493,069 (43.8)	1,425,083 (43.8)	67,986 (43.6)	14,015 (38.9)	4511 (36.4)
College/university	1,040,079 (30.5)	991,246 (30.5)	48,833 (31.3)	7766 (21.6)	2067 (16.7)
Underlying medical conditions (Jan 2020)					
Obesity (diagnosis)	71,291 (2.1)	66,885 (2.1)	4406 (2.8)	1501 (4.2)	460 (3.7)
Hypertension	827,673 (24.3)	786,170 (24.2)	41,503 (26.6)	17,784 (49.4)	7655 (61.8)
Diabetes	341,961 (10.0)	322,985 (9.9)	18,976 (12.2)	8621 (23.9)	3290 (26.6)
COPD	137,041 (4.0)	129,212 (4.0)	7829 (5.0)	4333 (12.0)	1687 (13.6)
Malignancy	159,805 (4.7)	152,646 (4.7)	7159 (4.6)	2385 (6.6)	951 (7.7)
Myocardial infarction	175,802 (5.2)	167,328 (5.1)	8474 (5.4)	3947 (11.0)	1753 (14.2)
Stroke	157,889 (4.6)	148,448 (4.6)	9441 (6.1)	4433 (12.3)	2238 (18.1)
Heart failure	137,179 (4.0)	127,645 (3.9)	9534 (6.1)	5552 (15.4)	2782 (22.5)
Atrial fibrillation	260,815 (7.6)	246,122 (7.6)	14,693 (9.4)	7132 (19.8)	3495 (28.2)

(*Continued*)

Table 2. *(Continued)*

	Total population	By COVID-19 infection			
		Non COVID-19 population	Any COVID-19[a]	Severe COVID-19[b]	Death from COVID-19
Number of individuals	3,410,241	3,254,224 (95.5)	156,017 (4.6)	35,999 (1.1)	12,384 (0.4)
Venous thromboembolism	145,920 (4.3)	138,063 (4.2)	7857 (5.0)	3132 (8.7)	1282 (10.4)
Dementia	68,949 (2.0)	60,068 (1.8)	8881 (5.7)	4008 (11.1)	3002 (24.2)
CCI	1.0 (1.2)	1.0 (1.2)	1.2 (1.4)	2.0 (1.6)	2.6 (1.6)

Note: Data are *n* (%) or mean (standard deviation).
Abbreviations: CCI, Charlson Comorbidity Index; COPD, chronic obstructive pulmonary disease.
[a]Any COVID-19 includes testing positive, hospitalization, and deaths.
[b]Severe COVID-19 includes hospitalization and deaths.
[c]Missing data for born in Nordic countries were 4.6%.
[d]Missing data for education were 1.7%.

for non-Nordic origin (4.6%) and area per habitant (3%), missing data were less than 1% (Table 2). Data in the main tables are from a single imputed dataset, and additional results are presented as appendix Tables S10–S15.

Logistic regression models—with the total population of this study as the denominator—were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs). Four models were developed and reported: Model 1—separate univariate models tested odds for each variable alone, Model 2—models adjusted for comorbidities and all other variables; Model 3—multivariable-adjusted models without interactions, and Model 4—multivariable-adjusted models with interactions, between age and need of care, and age and Nordic origin (see Tables S16 and S17 for details). Most comorbidities (except hypertension, venous thromboembolism, and obesity) were included in the CCI scale and therefore discarded in analyses where the role of this index was assessed.

Need of care naturally varies greatly with age and being born in Nordic countries. The interaction effect was shown using contrasts to estimate the OR for individuals at a specific age, need of care, and born in Nordic countries with a reference of age 65–74 years, born in Nordic countries, and living independently. Variables for adjustment in the models included age, sex, CCI, alternatively comorbidities, need of care, education, community type, and socioeconomic factors.

Population-attributable fraction (PAF), defined as the fraction of all cases of a particular outcome in a population that is attributable to a specific exposure, was calculated using the method of Bruzzi et al. using the R package "AF" [19, 20]. PAF was not calculated for continuous variables.

Results

Until the summer of 2021, in Sweden COVID-19 mortality—the most comparable measure between countries—followed the pattern of many other European countries, with a high peak in April 2020, followed by a second wave peaking in January 2021 (Fig. S1). During the spring of 2021, there was a third wave of infections.

Of the 3,410,241 persons aged 55 years and older, 156,017 (4.6%) were infected, hospitalized, and/or deceased with a diagnosis of COVID-19 during the study period (Table 1). In total, there were 12,384 (0.4%) deaths, with population COVID-19 death rates of 0.04%, 0.1%, 0.5%, 1.9%, and 4.0% among individuals aged 55–64, 65–74, 75–84, 85–94, and 95 years and above, respectively. Of all deaths, 5946 (48.0%) occurred outside the hospital. The proportion dying outside the hospital setting was 16.8% among those aged 55–64 and 72.2% among those aged 95 and above. Only 9.5% of all deaths occurred among patients treated in intensive care. Among hospitalized patients, 22.5% died (32.2% of intensive care patients). CFRs—estimated during the second period—ranged from 0.3% in the youngest group to 33.7% in the oldest.

The mean age of those without known SARS-CoV-2 infection was 69.8 (standard deviation [SD] 10.0 years; Table 2). The corresponding mean age

among those with severe COVID-19 was 76.7 (SD 11.6) years, while the mean age in fatal cases was 84.0 (SD 9.0) years. Among those without known infection, 10.9% were born outside the Nordic countries, compared to 18.0% among those with any COVID-19, and 20.3% of those with severe COVID-19 (Table 2) (10.1% among fatal cases in older individuals and where the country of birth was frequently not recorded). A lower proportion of infected individuals lived in a suburban or rural area, compared to urban, and the small area mean population density was higher. Among those without known infection, there was also slightly more living space per person compared to those with COVID-19. Age-specific characteristics are shown in Tables S5–S9.

Of those individuals without known infection, 7.9% had either home care or lived in a long-term care facility, compared with 18.2% of those with any COVID-19, and 38.6% among those with severe COVID-19 (68.2% of deaths; Table 2). The CCI was higher among individuals with severe COVID-19 and in fatalities than among those without known infection (2.0 and 2.6, compared to 1.0). All underlying medical conditions were more common among individuals in the large group diagnosed with any COVID-19 relative to those without known infection, and markedly more so among those with severe COVID-19. This was true for all age groups up to 85 years. Among those aged 85–94, there were some noticeable differences: 5.5% in the non-COVID-19 population had a diabetes diagnosis compared to 23.6% among those who died. The corresponding difference for heart failure was 14.4% in those without known infection compared to 25.4% among those who died. However, among persons 95 years and older, differences were minor or nonexistent.

After adjustment for age, sex, CCI, and demographics, home care and long-term care were associated with a 7.9-fold and 22.5-fold increase in odds of death, while PAFs were 21.9% (95% CI 20.9%–22.9%) and 33.3% (95% CI 32.4%–34.3%), respectively (Fig. 1). The ICD-based CCI score was associated with an OR of 1.44, 95% CI 1.43–1.45, for COVID-related death for each one-unit increase, which was attenuated to 1.13, 95% CI 1.12–1.14, after multivariable adjustment, with interaction effects. Non-Nordic origin was associated with doubled odds for COVID-related death, while higher education was protective, and population density was associated with a higher OR, as was number of persons in the household. Multivariable-adjusted PAFs for odds of COVID-19 death were 21.9% (95%CI 20.9%–22.9%) for home care and 33.3% (95% CI 32.4%–34.3%) for long-term care, while the PAF for hypertension was 11.8% (95% CI 9.6%–13.9%).

The association between age and odds of any COVID-19 was U-shaped, with people aged 75–84 having the lowest odds (Fig. 2). Odds of severe COVID-19 increased with age, although less sharply than for mortality (Fig. S2). The CCI and assisted living were less strong risk factors for any and severe COVID-19 than for death. Figures S3–S5 (appendix) show ORs and PAFs for any and severe COVID-19, and for COVID-19 death, with adjustment for separate comorbidities instead of the CCI. Each of the comorbidities conferred only a slight increase in the odds of testing positive for SARS-CoV-2 infection, or any COVID-19 diagnosis, except for dementia, with a 1.6-fold higher OR. However, with respect to severe COVID-19 and death, each of the comorbidities was associated with increased odds to a significant but varying degree. Still, ORs and PAFs associated with home care and being in a long-term care facility did not change materially, compared to adjustment for the CCI instead of separate comorbidities.

Figure 3 shows the multivariable effects with interactions on mortality for the three main exposures of age, non-Nordic origin, and need of care after adjustment for all variables (individual interaction components are described in Table S17). Compared with a reference group of persons of Nordic origin aged 65–74 years and living independently, those of the same age, living independently, but of non-Nordic origin had doubled odds of COVID-related death (OR 1.94, 95% CI 1.71–2.22). At all ages, individuals of non-Nordic—compared to Nordic—origin living independently had higher ORs, but with less difference with advancing age. All persons with either home care or long-term care had markedly higher ORs than those in independent living, beginning among those aged 55–64 years and rising with age to more than 70 times higher odds in those in the oldest age group in long-term care. The association between being born in a non-Nordic country and risk of testing positive for SARS-CoV-2 infection, severe COVID-19, and death waned with age, as did the association between living in long-term care and death. The associations between home care, living in a long-term care facility, and any or severe

Odds ratios and population attributable fraction for death from COVID−19

	Model 1	Model 2	Model 3	Model 4	Model 4 (PAF)
Age, years					
55 to 64	0.27 (0.24−0.3)	0.34 (0.31−0.38)	0.33 (0.3−0.37)	0.32 (0.28−0.37)	−6.2% (−6.9−−5.6)
65 to 74	Reference	Reference	Reference	Reference	0% (0−0)
75 to 84	4.07 (3.83−4.33)	3.17 (2.98−3.37)	2.44 (2.29−2.6)	2.7 (2.47−2.95)	16.8% (15.5−18.1)
85 to 94	15.51 (14.62−16.45)	10.09 (9.49−10.72)	4.22 (3.95−4.51)	7.71 (7−8.5)	29% (27.4−30.5)
95 and above	32.42 (30.03−34.99)	20.61 (19.06−22.29)	5.26 (4.82−5.72)	16.83 (13.62−20.79)	7.5% (6.8−8.1)
Sex, Male	1.24 (1.2−1.28)	1.18 (1.14−1.22)	1.99 (1.92−2.07)	1.94 (1.87−2.02)	25.3% (23.9−26.7)
Nordic origin, No	1.03 (0.97−1.08)	1.26 (1.19−1.33)	1.59 (1.5−1.69)	2.01 (1.76−2.29)	4.4% (3.8−5)
Residential area					
Urban	Reference	Reference	Reference	Reference	0% (0−0)
Suburban	0.72 (0.68−0.77)	0.7 (0.65−0.75)	0.92 (0.85−0.99)	0.92 (0.86−0.99)	−0.7% (−1.2−−0.1)
Rural	0.41 (0.39−0.44)	0.44 (0.41−0.47)	1.37 (1.24−1.51)	1.37 (1.24−1.51)	2.4% (1.7−3.2)
Population density (log)	1.16 (1.16−1.17)	1.16 (1.15−1.17)	1.15 (1.14−1.17)	1.15 (1.13−1.17)	
Area per habitant (per 10 m²)	0.91 (0.9−0.92)	0.9 (0.89−0.91)	0.97 (0.96−0.98)	0.97 (0.96−0.98)	
Number of habitants in household	0.58 (0.57−0.6)	0.71 (0.69−0.73)	1.01 (1−1.02)	1.01 (1−1.03)	
Education in 2018					
<=9 years	Reference	Reference	Reference	Reference	0% (0−0)
10−12 years	0.46 (0.44−0.47)	0.58 (0.56−0.61)	0.93 (0.89−0.97)	0.93 (0.9−0.97)	−2.6% (−4.1−−1)
University	0.3 (0.28−0.31)	0.45 (0.43−0.47)	0.78 (0.74−0.82)	0.78 (0.74−0.83)	−4.6% (−5.6−−3.6)
Income per habitant (log)	0.83 (0.82−0.84)	0.82 (0.81−0.83)	0.95 (0.92−0.98)	0.98 (0.95−1.01)	
Need of care					
Independent living	Reference	Reference	Reference	Reference	0% (0−0)
Home care	16.18 (15.47−16.93)	9.37 (8.91−9.84)	5.15 (4.88−5.42)	7.89 (6.82−9.13)	21.9% (20.9−22.9)
Longterm care facility	39.85 (38.18−41.59)	24.45 (23.35−25.61)	11.96 (11.34−12.62)	22.47 (19.63−25.72)	33.3% (32.4−34.3)
Underlying medical conditions					
Obesity	1.81 (1.65−1.99)	0.82 (0.74−0.9)	1.43 (1.3−1.57)	1.39 (1.26−1.53)	1% (0.7−1.3)
Hypertension	5.09 (4.91−5.28)	2.56 (2.46−2.66)	1.25 (1.2−1.3)	1.25 (1.2−1.3)	11.8% (9.6−13.9)
VTE	2.6 (2.45−2.75)	1.43 (1.35−1.52)	1.16 (1.09−1.23)	1.15 (1.09−1.23)	1.3% (0.7−1.9)
Charlson Comorbidity Index	1.44 (1.43−1.45)	1.34 (1.33−1.35)	1.13 (1.12−1.14)	1.13 (1.12−1.14)	

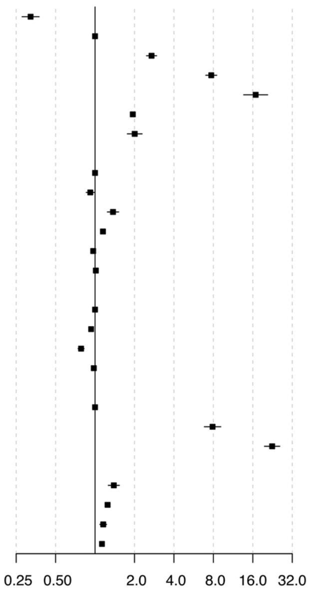

Fig. 1 *Odds ratios and population-attributable fraction for COVID-19 death. Abbreviations: PAF, population-attributable fraction; VTE, venous thromboembolism. Odds ratios for frailty were calculated as per unit increase of the Charlson Comorbidity Index. Model 1: univariate, Model 2: adjusted for comorbidities, Model 3: multivariable adjusted model (age group, sex, Nordic origin, residential area, population density [log], area per habitant, number of habitants in household, education, need of care, and underlying medical conditions), Model 4: as model 3, with interactions as described in Table S16.*

Odds ratios and population attributable fraction for any COVID−19

	Model 1	Model 2	Model 3	Model 4	Model 4 (PAF)
Age, years					
55 to 64	2.24 (2.21–2.27)	2.39 (2.35–2.42)	2.2 (2.17–2.23)	2.39 (2.36–2.43)	25.9% (25.4–26.3)
65 to 74	Reference	Reference	Reference	Reference	0% (0–0)
75 to 84	1.02 (1–1.04)	0.94 (0.93–0.96)	0.89 (0.87–0.9)	0.81 (0.79–0.82)	−1.3% (−1.5–−1)
85 to 94	2.22 (2.18–2.26)	1.92 (1.89–1.96)	1.23 (1.2–1.26)	1.21 (1.17–1.25)	2.7% (2.4–2.9)
95 and above	3.68 (3.54–3.82)	3.14 (3.02–3.26)	1.34 (1.28–1.39)	1.91 (1.7–2.14)	0.6% (0.6–0.7)
Sex, Male	0.97 (0.96–0.98)	0.97 (0.96–0.98)	0.99 (0.98–1)	0.99 (0.98–1)	−0.3% (−0.8–0.2)
Nordic origin, No	1.79 (1.77–1.82)	1.83 (1.81–1.86)	1.57 (1.55–1.59)	2.06 (2–2.12)	6.1% (5.9–6.3)
Residential area					
Urban	Reference	Reference	Reference	Reference	0% (0–0)
Suburban	0.78 (0.76–0.79)	0.77 (0.76–0.79)	0.96 (0.94–0.98)	0.96 (0.94–0.98)	−0.3% (−0.5–−0.2)
Rural	0.63 (0.62–0.64)	0.63 (0.62–0.64)	1.04 (1.01–1.07)	1.03 (1.01–1.06)	0.4% (0.1–0.7)
Population density (log)	1.09 (1.09–1.1)	1.09 (1.09–1.1)	1.07 (1.06–1.07)	1.07 (1.06–1.07)	
Area per habitant (per 10 m²)	0.92 (0.91–0.92)	0.91 (0.91–0.92)	0.98 (0.97–0.98)	0.98 (0.97–0.98)	
Number of habitants in household	1.12 (1.12–1.13)	1.13 (1.13–1.14)	1.08 (1.07–1.08)	1.08 (1.07–1.08)	
Education in 2018					
<=9 years	Reference	Reference	Reference	Reference	0% (0–0)
10–12 years	1.01 (1–1.03)	1.04 (1.03–1.05)	1.02 (1–1.03)	1.01 (1–1.02)	0.4% (−0.2–0.9)
University	1.05 (1.03–1.06)	1.09 (1.07–1.1)	0.98 (0.97–1)	0.97 (0.96–0.99)	−0.8% (−1.3–−0.4)
Income per habitant (log)	1.13 (1.12–1.14)	1.15 (1.14–1.16)	1.26 (1.25–1.27)	1.24 (1.23–1.25)	
Need of care					
Independent living	Reference	Reference	Reference	Reference	0% (0–0)
Home care	1.97 (1.94–2.01)	2.03 (1.99–2.07)	2.58 (2.52–2.63)	2.15 (2.04–2.27)	5.5% (5.3–5.6)
Longterm care facility	3.87 (3.8–3.95)	3.98 (3.9–4.06)	4.78 (4.67–4.89)	4.41 (4.16–4.67)	6.8% (6.7–7)
Underlying medical conditions					
Obesity	1.38 (1.34–1.43)	1.28 (1.24–1.32)	1.16 (1.13–1.2)	1.18 (1.14–1.22)	0.4% (0.3–0.5)
Hypertension	1.14 (1.12–1.15)	1.01 (1–1.03)	1.1 (1.09–1.12)	1.09 (1.08–1.11)	2.1% (1.8–2.5)
VTE	1.2 (1.17–1.23)	1.11 (1.09–1.14)	1.12 (1.09–1.15)	1.12 (1.1–1.15)	0.5% (0.4–0.6)
Charlson Comorbidity Index	1.05 (1.05–1.05)	1.04 (1.04–1.05)	1.04 (1.03–1.04)	1.04 (1.04–1.04)	

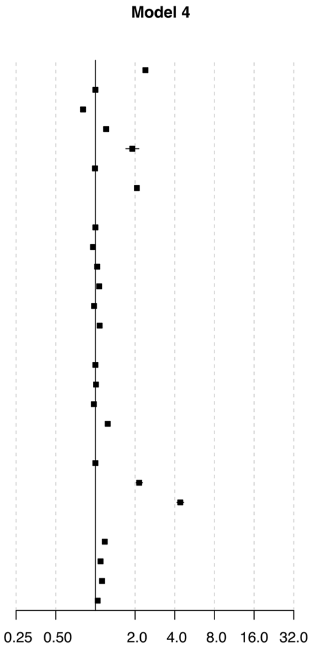

Fig. 2 *Odds ratios and population-attributable fraction for any COVID-19 (positive test or hospitalization or death). Abbreviations: PAF, population-attributable fraction; VTE, venous thromboembolism. Odds ratios for frailty were calculated as per unit increase of the Charlson Comorbidity Index. Model 1: univariate, Model 2: adjusted for comorbidities, Model 3: multivariable adjusted model (age group, sex, Nordic origin, residential area, population density [log], area per habitant, number of habitants in household, education, need of care, and underlying medical conditions), Model 4: as model 3, with interactions as described in Table S16.*

Odds ratios for death from COVID–19, by Age, Need of Care and Born in Nordic

Age group	Need of Care	Nordic origin	Model 3	Model4	Events	Population
55 to 64	Independent living	Yes	0.33 (0.3–0.37)	0.32 (0.28–0.37)	192	1009479
65 to 74	Independent living	Yes	Reference	Reference	620	961725
75 to 84	Independent living	Yes	2.44 (2.29–2.6)	2.7 (2.47–2.95)	1290	630875
85 to 94	Independent living	Yes	4.22 (3.95–4.51)	7.71 (7–8.5)	959	146360
95 and above	Independent living	Yes	5.26 (4.82–5.72)	16.83 (13.62–20.79)	93	6864
55 to 64	Home care	Yes	1.71 (1.52–1.94)	3.46 (2.53–4.72)	31	7061
65 to 74	Home care	Yes	5.15 (4.88–5.42)	7.89 (6.82–9.13)	212	21062
75 to 84	Home care	Yes	12.56 (11.64–13.56)	16.36 (14.82–18.06)	977	56931
85 to 94	Home care	Yes	21.73 (20.22–23.36)	25.99 (23.72–28.47)	1708	72679
95 and above	Home care	Yes	27.05 (24.74–29.56)	38.53 (33.96–43.72)	402	12336
55 to 64	Longterm care facility	Yes	3.98 (3.52–4.51)	5.54 (3.94–7.8)	36	4831
65 to 74	Longterm care facility	Yes	11.96 (11.34–12.62)	22.47 (19.63–25.72)	268	10726
75 to 84	Longterm care facility	Yes	29.19 (27.03–31.53)	41.85 (37.99–46.1)	1157	26282
85 to 94	Longterm care facility	Yes	50.51 (47.03–54.25)	59.93 (54.8–65.54)	2252	39655
95 and above	Longterm care facility	Yes	62.86 (57.72–68.46)	69.63 (62.42–77.66)	735	12186
55 to 64	Independent living	No	0.53 (0.47–0.6)	0.83 (0.69–0.99)	149	201828
65 to 74	Independent living	No	1.59 (1.5–1.69)	2.01 (1.76–2.29)	238	110226
75 to 84	Independent living	No	3.89 (3.56–4.25)	4.58 (4.05–5.17)	275	47854
85 to 94	Independent living	No	6.73 (6.13–7.38)	9.56 (8.34–10.97)	109	10359
95 and above	Independent living	No	8.37 (7.52–9.32)	19.88 (14.23–27.77)	9	336
55 to 64	Home care	No	2.73 (2.39–3.12)	8.89 (6.44–12.28)	15	1806
65 to 74	Home care	No	8.2 (7.57–8.87)	15.84 (13.03–19.25)	30	2974
75 to 84	Home care	No	20.01 (18.12–22.09)	27.73 (24.4–31.51)	140	5144
85 to 94	Home care	No	34.62 (31.43–38.13)	32.23 (28.18–36.85)	155	4362
95 and above	Home care	No	43.08 (38.56–48.13)	45.53 (34.09–60.8)	24	511
55 to 64	Longterm care facility	No	6.34 (5.53–7.27)	14.26 (9.87–20.61)	0	687
65 to 74	Longterm care facility	No	19.05 (17.56–20.68)	45.11 (37.13–54.81)	36	1013
75 to 84	Longterm care facility	No	46.51 (42.05–51.43)	70.94 (62.35–80.71)	117	1845
85 to 94	Longterm care facility	No	80.46 (72.98–88.71)	74.31 (64.95–85.03)	130	1881
95 and above	Longterm care facility	No	100.13 (89.77–111.69)	82.26 (61.76–109.58)	25	363

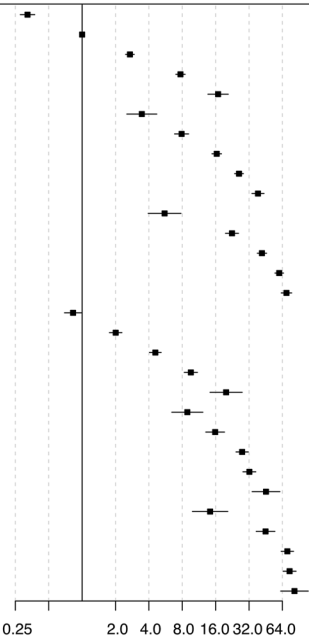

Fig. 3 *Odds ratios and population-attributable fraction for COVID-19 death, multivariable effects, with interactions between the three main exposures of age, non-Nordic origin, and need of care, on death by COVID-19. Reference group are those aged 65–74 with independent living and of Nordic origin.*

COVID-19 were less strong for any and severe COVID-19 than for death (Figs S6 and S7) and varied less systematically with age (Table S18).

Discussion

In this study describing the first year of the COVID-19 pandemic in Sweden in all persons aged 55 and older, almost four in every 1000 died and 1% were hospitalized. Deaths were concentrated among those with assisted living, who were frail, and with many comorbidities. These individuals were concomitantly exposed to many different people to an extent people living independently would not have been. Adjustment for comorbidities did not affect the associations between assisted living and severe COVID-19 outcomes.

While several nationwide studies have analyzed risk factors for severe COVID-19 cases and deaths, this is the first study to quantify PARs of severe COVID-19 and deaths in association with a range of medical disorders and sociodemographic factors, including data on residential care and home care. Given that many deaths occurred outside the hospital setting, studies providing data on hospital mortality alone do not provide the full picture of the effect of these separate factors [5, 21].

An early study of 61 million people from the United Kingdom found age and a range of medical conditions, male sex, non-White ethnicity, and deprivation to be associated with COVID-19 in-hospital mortality [21]. A study of over 17 million patients in England analyzed COVID-19-related deaths, with similar findings [5], with a second analysis of the same data investigating associations between individual-level characteristics and COVID-19 and non-COVID deaths. These analyses indicated that COVID-19 largely multiplies existing risks for mortality, but with older age, male sex, ethnicity, and obesity more strongly related to COVID-19 mortality than to all-cause mortality [22]. A recent British study found that COVID-19 had a disproportionate impact on the mortality of care-home residents in England compared to people of the same age living in private homes, but only in the first wave [23].

A French national cohort study of 66 million people confirmed the associations between age, male sex, deprivation, and medical conditions on hospitalizations and in-hospital death in COVID-19, adding several disorders to those already identified [4]. The strongest associations were found for Down syndrome, intellectual disability, kidney or lung transplantation, being on dialysis, and active lung cancer, most of which are rare and with short life expectancy. Similarly, a study based on the entire Swiss population used geocoding to examine social inequalities in relation to risk of COVID-19 infection, hospitalization, intensive care admissions, and deaths [3], with lower socioeconomic status associated with poorer outcomes. The associations became stronger after exclusion of individuals with addresses geocoded within 25 m of a nursing home. Social gradients in severe COVID-19 outcomes in Sweden—unrelated to pre-existing health disparities—have been demonstrated in a register-based study in a cohort of infected individuals; however, the study did not consider assisted living [24].

In almost all countries with COVID-19 deaths, a substantial proportion occurred among care-home residents [14, 16, 23, 25]. Early in the pandemic in Sweden, the virus spread in long-term care facilities, despite strict guidelines from the Public Health Agency of Sweden for older people to avoid face-to-face contacts, with a ban on visits to nursing homes from 1 April 2020 [13, 26]. Paradoxically, the most vulnerable individuals were also those least able to comply with these restrictions, as they were dependent on other people for their personal care. While there are several reports on care homes, many older people in Sweden and elsewhere receive community-based home care. So far, there has been limited evidence on how those individuals have been affected by COVID-19. Assisted, compared to independent, living emerged as being associated with the highest ORs for severe COVID-19 of all factors that we investigated. Taken together, in-home care and residential care corresponded to a PAR of over 50%. In an early study from Sweden that compared persons with COVID-19 infection with noninfected matched controls, persons living in long-term care were 10 times more often diagnosed with COVID-19 than controls. However, they were only marginally more likely to be hospitalized with COVID-19, and unlikely to receive intensive care, probably reflecting markedly different selective processes for these outcomes [1].

In the initial phase, personal protective equipment for the staff was lacking in many countries, including Sweden [25, 27]. The Swedish approach to handling the pandemic received some attention, chiefly because—unlike in most other countries—there was no formal lockdown [26]. However, there

was a general goal based on personal responsibility to minimize transmission through standard measures, such as minimizing contacts among people, physical distancing, and enhanced hygiene routines, in combination with testing regimes, contact tracing, and quarantining. Early on, there were efforts to pinpoint risk groups and risk areas and to tailor measures to minimize transmission, particularly among older adults [13]. High population death rates compared to the rest of Europe were noted in mid-April 2020 and again in January 2021. However, excess mortality has been considered a more reliable indicator of COVID-19 mortality, and Sweden's rates were slightly below midrange for high-income countries during 2020 [28].

Among the strengths of the present study is the availability of nationwide data on multiple medical, social, and demographic dimensions, and the inclusion of out-of-hospital deaths. The elevated risk associated with assisted living persisted even after adjustment for sociodemographic data and comorbidities. Accordingly, poor baseline health probably only partly explains the excess COVID-19 mortality. The risk of being infected due to exposure to many carers likely contributes to excess mortality among older adults. Weaknesses include the lack of testing during the first massive outbreak—a limitation applicable to many countries—and that only hospital diagnoses of comorbid conditions were captured, which will have underestimated the prevalence of hypertension and diabetes and of obesity. We did not, by design, control for medical conditions occurring after January 2020, which means that the influence of recent events on severe COVID-19 could not be considered. Also, while the use of logistic regression simplifies the analyses, the effect sizes estimated will be average effects over the whole study period. Additionally, there are likely older persons with no registered home care who are assisted by multiple family members, who also face a higher likelihood of being infected. With newer variants of the virus, altered patterns of infection, morbidity, and mortality will emerge.

Conclusion

In conclusion, in this nationwide study of persons aged 55 and older, assisted living was a decisive factor for death or severe illness among the very old, with a high proportion of deaths attributable to this even after considering multimorbidity. These individuals were likely exposed to more people than those who lived independently, which may account for the higher incidence of infection. High vaccination rates in older persons and exposure to fewer carers should take priority in the prevention of COVID-19 death and severe disease.

Funding

This work was supported by grants from the Swedish state under an agreement concerning research and education of doctors (ALFGBG-717211 [A. R.] and ALFGBG-965885 [M. G.]), the Swedish Heart and Lung Foundation (2018-0366), the Swedish Research Council (2018-02527 [A. R.], 2020–05792 [A. R.], 2021–06545 [M. G.], VRREG 2019-00193 [A. R.], 2019–00198 [J. B.], 2019-00245 [M. B.], and 2019-00209 [J. L.]), Science for Life Laboratory from the Knut and Alice Wallenberg Foundation (2020.0241) (M. G.), and the Swedish Research Council for Health, Working Life and Welfare (2021-00304) (M. Å.).

Conflict of interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

References

1 Bergman J, Ballin M, Nordstrom A, Nordstrom P. Risk factors for COVID-19 diagnosis, hospitalization, and subsequent all-cause mortality in Sweden: a nationwide study. *Eur J Epidemiol.* 2021;**36**:287–98.
2 Ho FK, Celis-Morales CA, Gray SR, Katikireddi SV, Niedzwiedz CL, Hastie C, et al. Modifiable and non-modifiable risk factors for COVID-19, and comparison to risk factors for influenza and pneumonia: results from a UK Biobank prospective cohort study. *BMJ Open.* 2020;**10**:e040402.
3 Riou J, Panczak R, Althaus CL, Junker C, Perisa D, Schneider K, et al. Socioeconomic position and the COVID-19 care cascade from testing to mortality in Switzerland: a population-based analysis. *Lancet Public Health.* 2021;**6**:e683–91.
4 Semenzato L, Botton J, Drouin J, Cuenot F, Dray-Spira R, Weill A, et al. Chronic diseases, health conditions and risk of COVID-19-related hospitalization and in-hospital mortality during the first wave of the epidemic in France: a cohort study of 66 million people. *Lancet Reg Health Eur.* 2021;**8**:100158.
5 Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, et al. Factors associated with COVID-19-related death using OpenSAFELY. *Nature.* 2020;**584**:430–6.
6 Vila-Corcoles A, Satue-Gracia E, Vila-Rovira A, de Diego-Cabanes C, Forcadell-Peris MJ, Hospital-Guardiola I, et al. COVID19-related and all-cause mortality risk among middle-aged and older adults across the first epidemic wave of SARS-COV-2 infection: a population-based cohort study in Southern Catalonia, Spain, March–June 2020. *BMC Public Health.* 2021;**21**:1795.

7 Ioannidis JPA, Axfors C, Contopoulos-Ioannidis DG. Population-level COVID-19 mortality risk for non-elderly individuals overall and for non-elderly individuals without underlying diseases in pandemic epicenters. *Environ Res.* 2020;**188**:109890.
8 Leso V, Fontana L, Iavicoli I. Susceptibility to coronavirus (COVID-19) in occupational settings: the complex interplay between individual and workplace factors. *Int J Environ Res Public Health.* 2021;**18**:1030.
9 Drefahl S, Wallace M, Mussino E, Aradhya S, Kolk M, Brandén M, et al. A population-based cohort study of socio-demographic risk factors for COVID-19 deaths in Sweden. *Nat Commun.* 2020;**11**:5097.
10 Mutambudzi M, Niedwiedz C, Macdonald EB, Leyland A, Mair F, Anderson J, et al. Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. *Occup Environ Med.* 2020;**78**:307–14.
11 Carlsten C, Gulati M, Hines S, Rose C, Scott K, Tarlo SM, et al. COVID-19 as an occupational disease. *Am J Ind Med.* 2021;**64**:227–37.
12 Rostila M, Cederstrom A, Wallace M, Branden M, Malmberg B, Andersson G. Disparities in coronavirus disease 2019 mortality by country of birth in Stockholm, Sweden: a total-population-based cohort study. *Am J Epidemiol.* 2021;**190**:1510–8.
13 Tegnell A. The Swedish public health response to COVID-19. *APMIS.* 2021;**129**:320–3.
14 Comas-Herrera A, Zalakaín J, Lemmon E, Henderson D, Litwin C, Hsu AT, et al. Mortality associated with COVID-19 in care homes: international evidence. International Long-Term Care Policy Network, CPEC-LSE, 14 October 2020.
15 Modig K, Lambe M, Ahlbom A, Ebeling M. Excess mortality for men and women above age 70 according to level of care during the first wave of COVID-19 pandemic in Sweden: a population-based study. *Lancet Reg Health Eur.* 2021;**4**:100072.
16 Brandén M, Aradhya S, Kolk M, Härkönen J, Drefahl S, Malmberg B, et al. Residential context and COVID-19 mortality among adults aged 70 years and older in Stockholm: a population-based, observational study using individual-level data. *Lancet Healthy Longev.* 2020;**1**(2):e80–8.
17 Ludvigsson JF, Appelros P, Askling J, Byberg L, Carrero JJ, Ekström AM, et al. Adaptation of the Charlson Comorbidity Index for register-based research in Sweden. *Clin Epidemiol.* 2021;**13**:21–41.
18 van Buuren S, Groothuis-Oudshoorn K. MICE: Multivariate Imputation by Chained Equations in R. *J Stat Softw.* 2011;**45**:1–67.
19 Bruzzi P, Green SB, Byar DP, Brinton LA, Schairer C. Estimating the population attributable risk for multiple risk factors using case-control data. *Am J Epidemiol.* 1985;**122**:904–14.
20 Mansournia MA, Altman DG. Population attributable fraction. *BMJ.* 2018;**360**:k757.
21 Barron E, Bakhai C, Kar P, Weaver A, Bradley D, Ismail H, et al. Associations of type 1 and type 2 diabetes with COVID-19-related mortality in England: a whole-population study. *Lancet Diabetes Endocrinol.* 2020;**8**:813–22.
22 Bhaskaran K, Bacon S, Evans SJ, Bates CJ, Rentsch CT, MacKenna B, et al. Factors associated with deaths due to COVID-19 versus other causes: population-based cohort analysis of UK primary care data and linked national death registrations within the OpenSAFELY platform. *Lancet Reg Health Eur.* 2021;**6**:100109.
23 Schultze A, Nightingale E, Evans D, Hulme W, Rosello A, Bates C, et al. Mortality among care home residents in England during the first and second waves of the Covid-19 pandemic: an observational study of 4.3 million adults over the age of 65. *Lancet Reg Health Eur.* 2022;**14**:100295.
24 Gustafsson PE, San Sebastian M, Fonseca-Rodriguez O, Fors Connolly AM. Inequitable impact of infection: social gradients in severe COVID-19 outcomes among all confirmed SARS-CoV-2 cases during the first pandemic wave in Sweden. *J Epidemiol Community Health.* 2021;**76**:261–7.
25 Gordon AL, Goodman C, Achterberg W, Barker RO, Burns E, Hanratty B, et al. Commentary: COVID in care homes-challenges and dilemmas in healthcare delivery. *Age Ageing.* 2020;**49**:701–5.
26 Ludvigsson JF. The first eight months of Sweden's COVID-19 strategy and the key actions and actors that were involved. *Acta Paediatr.* 2020;**109**:2459–71.
27 Palacios-Ceña D, Fernández-Peña R, Ortega-López A, Fernández-Feito A, Bautista-Villaécija O, Eodrigo-Pedrosa O, et al. Long-term care facilities and nursing homes during the first wave of the COVID-19 pandemic: a scoping review of the perspectives of professionals, families and residents. *Int J Environ Res Public Health.* 2021;**18**:10099.
28 Islam N, Shkolnikov VM, Acosta RJ, Klimkin I, Kawachi I, Irizarry RA, et al. Excess deaths associated with Covid-19 pandemic in 2020: age and sex disaggregated time series analysis in 29 high income countries. *BMJ.* 2021;**373**:n1137.

Correspondence: Annika Rosengren, Department of Molecular and Clinical Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Diagnosvägen 11, 41650 Gothenburg, Sweden.
Email: annika.rosengren@gu.se

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix
Table S1. Definitions of baseline comorbidities.
Table S2. Main diagnoses used together with a secondary COVID-19 diagnosis.
Table S3. Modification of Charlson Comorbidity Index.
Table S4. Distribution of COVID-19 as principal or underlying, and as contributory diagnoses.
Table S5. Participant characteristics among individuals aged 55 to 64 years in January, 2020, stratified by COVID-19 infection and severity.
Table S6. Participant characteristics among individuals aged 65 to 74 years in January, 2020, stratified by COVID-19 infection and severity.
Table S7. Participant characteristics among individuals aged 75 to 84 years in January, 2020, stratified by COVID-19 infection and severity.

Table S8. Participant characteristics among individuals aged 85 to 94 years (in January 2020), stratified by COVID-19 infection and severity.
Table S9. Participant characteristics among individuals aged 95 and above in January, 2020, stratified by COVID-19 infection and severity.
Table S10. Results for five imputed dataset, OR (95% CI) for any COVID-19.
Table S11. Results for five imputed dataset, OR (95% CI) for severe COVID-19.
Table S12. Results for five imputed dataset, OR (95% CI) for death from COVID-19.
Table S13. Age specific (January 2020) results for five imputed dataset, OR (95% CI) for any COVID-19.
Table S14. Age specific (January 2020) results for five imputed dataset, OR (95% CI) for severe COVID-19.
Table S15. Age specific (January 2020) results for five imputed dataset, OR (95% CI) for death from COVID-19.
Table S16. Model specifications.
Table S17. Beta coefficients of model 4, Multivariable adjusted model with interactions.
Table S18. Age specific (January 2020) ORs (95% CI) and PAR (95% uncertainty interval) for being born outside a Nordic country and need of care, multivariable adjusted.

Figure S1. Weekly new confirmed COVID-19 cases, severe cases (hospitalizations or deaths) and deaths per 100 000 by age group. Testing during the first wave was performed in selected cases only.
Figure S2. Odds ratios and population attributable fraction for severe COVID-19 univariate and multivariable-adjusted models, including selected comorbidities and Charlson Comorbidity Index.
Figure S3. Odds ratios and population attributable fraction for any COVID-19 in univariate and multivariable-adjusted models, including comorbidities.
Figure S4. Odds ratios and population attributable fraction for severe COVID-19 in univariate and multivariable-adjusted models, including comorbidities.
Figure S5. Odds ratios and population attributable fraction for death from COVID-19 in univariate and multivariable-adjusted models, including comorbidities.
Figure S6. Multivariable effects, odds ratios with interactions between the three main exposures of age, non-Nordic origin and need of care, on any COVID-19.
Figure S7. Multivariable effects, odds ratios with interactions between the three main exposures of age, non-Nordic origin and need of care, on severe COVID-19. ■