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## Short communication

# Differences by region of birth in SARS-CoV-2 vaccine coverage and positive SARS-CoV-2 test among 400 000 healthcare workers and the general population in Sweden

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## ABSTRACT

**Background:** Globally SARS-CoV-2 vaccine coverage varies among healthcare workers.**Methods:** Based on Swedish registers, data on vaccination status as of 31 October 2021 were analysed for all adults aged 35–64 years, 3 861 565 individuals, in Sweden by healthcare worker occupation group and region of birth.**Results:** For both men and women vaccination coverage decreased in a graded manner by healthcare worker group with physicians having the highest coverage (96%), followed by registered nurses, licensed practical nurses, and nurse aides. Coverage also differed by region of birth for all groups of healthcare workers and non-healthcare workers with those born in Sweden with Sweden born parents having the highest coverage, and those born outside Sweden but within EU the lowest.**Conclusion:** The difference in vaccine coverage by region of birth among healthcare workers, regardless of whether it results from socioeconomic inequalities or sociocultural beliefs, puts them at a great occupational hazard and increased risk of nosocomial transmission.© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

Sweden implemented on 27th December 2020 a phased vaccine distribution plan against severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) [1]. Initially those living in nursing homes were prioritized followed by staff and healthcare workers (HCW) at nursing homes and assisted living facilities. The priority of HCWs was based on their increased risk of being infected in addition to a high potential risk of contributing to nosocomial transmission.

A qualitative study in Europe in 2016, long before the SARS-CoV-2 pandemic, showed that vaccine hesitancy is present among HCW foremost due to fear of side effects [2]. Vaccine acceptance during the pandemic has varied among HCW. By March 2021, in a hospital in United Kingdom (UK), vaccine coverage was higher among physicians than among other groups of HCW, and higher

among white and Asian but lower among black and Afro-Caribbean [3]. In contrast, a global survey showed higher vaccine willingness in low- and middle-income countries compared with the United States (US) and Russia [4]. In another qualitative assessment, vaccine hesitancy among HCW in the UK was reported attributable to lack of trust in government, and safety concerns [5]. Vaccine hesitancy among HCW in the US decreased from fall 2020 to early spring 2021 [6]. In another US study, intention to be vaccinated was higher among HCW with longer educational requirements [7]. A survey of availability of vaccine coverage data for HCW in the Nordic countries showed that such data were not systematically collected on national level [8], however by linking the national vaccination register in Sweden to information on occupation, such data are now available [9].

This study aims to determine differences by region of birth in vaccine coverage and positive SARS-CoV-2-testing among HCW in Sweden compared with non-HCW by using national registers with complete data regarding occupation, country of birth and vaccination status.

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## 2. Method

### 2.1. Study design

The study population comprises all adults aged 35–64 years, permanently residing in Sweden and alive on 31 October 2021 as registered in the Total Population Register [10]. This register also yielded information on region of birth [10]. Vaccination status, retrieved from the national vaccination register, by HCW occupational group is presented as of 31 October 2021, when vaccination was opened for all ages 12 years and older, in total 3 861 565 individuals [9]. Information on latest occupation (as of the status in November 2018), and mother's and father's region of birth was retrieved from the nationwide longitudinal integrated database for health insurance and labour market studies (LISA). A positive polymerase chain reaction test or lateral flow test of SARS-CoV-2 was retrieved from the register on surveillance of notifiable communicable diseases [11]. Data are part of the COvid-19 VACcination register SAFETy study in Sweden (CoVacSafe-SE) and have been described in detail elsewhere [12].

### 2.2. Classification of healthcare workers and region of birth

#### 2.2.1. Healthcare workers

HCW were classified into four groups according to the Swedish Standard Classification of Occupations (SSYK) [13] and ordered by length of post-compulsory education; Physician, registered nurse, licensed practical nurse, and one group including nursing assistant, nurse aide, and psychiatric aide, and as comparison group all others as non-HCW.

According to the Swedish Medical Subject Headings (MeSH) the Swedish occupations under study correspond to the following definitions [14]; *Physician*: Individuals licensed to practice medicine. *Registered nurse*: Professionals qualified by graduation from an accredited school of nursing and by passage of a national licensing examination to practice nursing. They provide services to patients requiring assistance in recovering or maintaining their physical or mental health. *Licensed practical nurse*: Health personnel who do not hold professional degrees or credentials but have completed training and are licensed to provide routine patient care under the direction of registered nurses and physicians. *Nursing assistant, nurse aide and psychiatric aide*: Persons who assist in the routine care of patients in psychiatric or somatic care, usually under the supervision of the nursing department.

### 2.3. Region of birth

Region of birth was categorized into four mutually exclusive groups by a combination of the person's own country of birth and his or her parents' country of birth, similar to the categorization used by Statistics Sweden [15]. Region of birth was grouped into: (i) Person born in Sweden with both parents born in Sweden or where the parents' country of birth is unknown (foremost elderly), (ii) Second-generation immigrant, person born in Sweden with at least one parent born outside Sweden, (iii) First-generation immigrant, person born in Europe, (iv) First-generation immigrant, person born outside Europe.

### 2.4. Classification of outcome

#### 2.4.1. SARS-CoV-2 vaccination

The national vaccination register contains since 1st January 2021 information on SARS-CoV-2 vaccination [9]. Date of vaccination for first dose and second dose of SARS-CoV-2 vaccination was retrieved from the register.

### 2.5. Statistical analyses

Proportions of the population vaccinated with one dose only, two doses or unvaccinated and proportion positive SARS-CoV-2 test are presented by healthcare occupation groups and region of birth, stratified by sex and age. Due to integrity reasons any number <10 is presented as <10. The population under study is the total population, hence, no statistical tests or confidence intervals are presented.

## 3. Results

In total, 3 861 565 individuals aged 35–64 years were included, 1 961 787 (50.8%) men and 1 899 778 (49.2%) women. Among the male population 14 932 (0.76%) were physicians, 8588 (0.44%) registered nurses, 11 389 (0.58%) licensed practical nurses, and 37 502 (1.91%) nursing assistants, and corresponding numbers for the female population 17 092 (0.90%) physicians, 69 751 (3.76%) registered nurses, 126 042 (6.63%) licensed practical nurses, 112 220 (5.91%) nursing assistants (Table 1).

For both men and women aged 50–64 vaccination coverage (2-doses) decreased in a graded manner (by educational requirements) by HCW group with physicians having the highest coverage (96%) and nurse aides the lowest. Vaccination coverage differed by region of birth for all groups of HCW as well as among non-HCW with those Sweden born with Sweden born parents having the highest coverage and those born within EU the lowest. Among Sweden born all groups of HCW except nurse aides had higher coverage than non-HCW. Among those foreign born all groups of HCW had higher coverage than non-HCW (Table 2).

Correspondingly, among both men and women aged 35–49 vaccination coverage (2 doses) decreased in a graded manner by HCW group and differed by region of birth as for the older age group 50–64 but the differences between HCW groups and between country of birth were larger (Table 3).

Among both men and women born in Sweden by Sweden born parents, 11–13% of physicians, registered nurses, and licensed practical nurses were registered as SARS-CoV-2 positive in 2020, compared to 10–18% among foreign-born. Among nurse aides, a positive SARS-CoV-2 test was also more common among those outside Sweden (9–11%) compared to Sweden-born (7%). In 2020, the proportion with a positive SARS-CoV-2 test among HCW was higher than in non-HCW. In 2021, a positive SARS-CoV-2 test was also more common among foreign-born compared to Sweden-born, but the proportion with positive SARS-CoV-2 test among HCW was lower than in non-HCW (Table 4).

## 4. Discussion

In this national study on coverage of SARS-CoV-2 vaccination we show that up to 95% of physicians and registered nurses had been vaccinated with two doses by 31st October 2021. Licensed practical nurses and nurse aides had a lower coverage, but in general higher than non-HCW, except for nurse aides born in Sweden who had a lower coverage than non-HCW of Swedish born. Older HCW had higher coverage than younger. We also show that in all HCW groups Sweden-born had a higher coverage than their foreign-born counterparts. Positive SARS-CoV-2 test in 2021 was slightly more common among foreign-born HCW compared to Sweden-born.

Despite the high vaccination coverage among physicians and registered nurses the difference by region of birth in vaccine coverage among all HCW is of concern. The Swedish National Council on Medical Ethics is an advisory board to the Swedish government on ethical issues in healthcare and biomedicine and has stated that all

**Table 1**  
Number of healthcare workers and non-health care workers aged 35–64, by country of birth, as of 31 October 2021, Sweden.

	Healthcare worker				Non-healthcare workers N (%)	Total N
	Physician N (%)	Registered Nurse N (%)	Licensed practical nurse N (%)	Nurse aide N (%)		
Men	14 932	8588	11 389	37 502	1 889 376	1 961 787
Sweden born by Sweden born	7594 (50.9)	6440 (75.0)	5603 (49.2)	19 852 (52.9)	1 222 589 (64.7)	1 262 078
Sweden born by foreign born	1529 (10.2)	840 (9.8)	910 (8.0)	3730 (10.0)	191 285 (10.1)	198 294
Born within EU	3109 (20.8)	582 (6.8)	852 (7.5)	3443 (9.2)	209 192 (11.1)	217 178
Born outside EU	2700 (18.1)	726 (8.4)	4024 (35.3)	10 477 (27.9)	266 310 (14.1)	284 237
Women	17 092	69 751	126 042	112 220	1 574 673	1 899 778
Sweden born by Sweden born	9370 (54.8)	53 824 (77.2)	80 190 (63.6)	67 418 (60.1)	998 738 (63.4)	1 209 540
Sweden born by foreign born	1672 (9.8)	6766 (9.7)	11 393 (9.0)	11 254 (10.0)	159 087 (10.1)	190 172
Born within EU	4107 (24.0)	4993 (7.2)	13 379 (10.6)	11 981 (10.7)	173 928 (11.1)	208 388
Born outside EU	1943 (11.4)	4168 (6.0)	21 080 (16.7)	21 567 (19.2)	242 920 (15.4)	291 678
Total	32 024	78 339	137 431	149 722	3 464 049	3 861 565

**Table 2**  
Proportion healthcare workers fully vaccinated (2doses), started vaccination (1dose) and unvaccinated, by country of birth, aged 50–64. Vaccination status as of 31 October 2021. Due to integrity reasons any number <10 is presented as <.

	Healthcare worker				Non-healthcare workers N (%)	Total N
	Physician N (%)	Registered Nurse N (%)	Licensed practical nurse N (%)	Nurse aide N (%)		
Men						
Sweden born by Sweden born	3234	2663	2946	9835	645 863	664 541
Unvaccinated	78 (2.4)	96 (3.6)	210 (7.1)	968 (9.8)	45 602 (7.1)	46 954
1 dose	51 (1.6)	38 (1.4)	64 (2.2)	238 (2.4)	9023 (1.4)	9414
2 doses	3105 (96.0)	2529 (95.0)	2672 (90.7)	8629 (87.7)	591 238 (91.5)	608 173
Sweden born by foreign born	616	359	404	1603	91 909	94 891
Unvaccinated	<20 (<3)	<20 (<5)	46 (11.4)	234 (14.6)	9361 (10.2)	9675
1 dose	<20 (<2)	<10 (<2)	14 (3.5)	42 (2.6)	1560 (1.7)	1632
2 doses	586 (95.1)	339 (94.4)	344 (85.2)	1327 (82.8)	80 988 (88.1)	83 584
Born within EU	1263	291	432	1764	93 459	97 209
Unvaccinated	170 (13.5)	<40 (<15)	<100 (<20)	417 (23.6)	25 213 (27.0)	25 904
1 dose	32 (2.5)	<10 (<2)	<10 (<2)	45 (2.5)	2093 (2.2)	2183
2 doses	1061 (84.0)	254 (87.3)	352 (81.5)	1302 (73.8)	66 153 (70.8)	69 122
Born outside EU	1190	338	1660	3998	93 718	100 904
Unvaccinated	<120 (<10)	<40 (<10)	222 (13.4)	672 (16.8)	20 614 (22.0)	21 642
1 dose	<40 (<4)	<10 (<3)	70 (4.2)	170 (4.2)	3147 (3.4)	3429
2 doses	1053 (88.5)	299 (88.5)	1368 (82.4)	3156 (78.9)	69 957 (74.6)	75 833
Women						
Sweden born by Sweden born	3218	27 491	50 413	39 295	521 749	642 166
Unvaccinated	82 (2.6)	846 (3.1)	2865 (5.7)	3609 (9.2)	33 609 (6.4)	41 011
1 dose	56 (1.7)	482 (1.8)	984 (2.0)	835 (2.1)	7625 (1.5)	9983
2 doses	3079 (95.7)	26 163 (95.2)	46 564 (92.4)	34 851 (88.7)	480 515 (92.1)	591 172
Sweden born by foreign born	485	3386	6603	5970	75 759	92 203
Unvaccinated	<20 (<3)	<200 (<6)	547 (8.3)	808 (13.5)	7295 (9.6)	8848
1 dose	<10 (<2)	<75 (<3)	153 (2.3)	154 (2.6)	1342 (1.8)	1723
2 doses	466 (96.1)	3133 (92.5)	5903 (89.4)	5008 (83.9)	67 122 (88.6)	81 632
Born within EU	1607	2640	7650	6406	81 406	99 709
Unvaccinated	211 (13.1)	329 (12.5)	1175 (15.4)	1483 (23.2)	19 989 (24.6)	23 187
1 dose	48 (3.0)	75 (2.8)	208 (2.7)	179 (2.8)	2043 (2.5)	2553
2 doses	1348 (83.9)	2236 (84.7)	6267 (81.9)	4744 (74.1)	59 374 (72.9)	73 969
Born outside EU	775	1799	8667	8046	85 081	104 368
Unvaccinated	72 (9.3)	163 (9.1)	975 (11.2)	1426 (17.7)	16 779 (19.7)	19 415
1 dose	20 (2.6)	49 (2.7)	389 (4.5)	374 (4.7)	3012 (3.5)	3844
2 doses	684 (88.3)	1586 (88.2)	7303 (84.3)	6246 (77.6)	65 290 (76.7)	81 109

HCW have a responsibility to get vaccinated [16]. There has been no official mandate for all HCW to get vaccinated. Some health care providers have raised this issue, but according to current legislation it is not possible to demand that HCW get vaccinated. However, under certain circumstances non-vaccinated employees could be assigned other work tasks.

Ethnic differences in vaccine hesitancy have been shown previously but not in the Nordic countries [2–8]. Explanations of vaccine hesitancy include concern around immediate side-effects and

long-term effects but also mistrust in information and in the government and pharmaceutical companies [5,17]. A lower level of health literacy may in part explain lower vaccine coverage among foreign-born in non-HCW but would not be expected to explain lower vaccine coverage among foreign-born HCW. Regardless of whether lower vaccine coverage in foreign-born HCW is an effect of mistrust in government and the healthcare system, socioeconomic inequalities, or due to sociocultural beliefs it is important to address vaccine hesitancy as these groups have an increased

**Table 3**

Proportion healthcare workers fully vaccinated (2doses), started vaccination (1dose) and unvaccinated, by country of birth, aged 35–49, Vaccination status as of 31 October 2021. Due to integrity reasons any number <10 is presented as <.

	Healthcare worker				Non-healthcare workers	Total
	Physician N (%)	Registered Nurse N (%)	Licensed practical nurse N (%)	Nurse aide N (%)	N (%)	N
<b>Men</b>						
Sweden born by Sweden born	4360	3777	2657	10 017	576 726	597 537
Unvaccinated	85 (2.0)	101 (2.7)	310 (11.7)	1620 (16.2)	64 735 (11.2)	66 851
1 dose	79 (1.8)	69 (1.8)	77 (2.9)	370 (3.7)	14 907 (2.6)	15 502
2 doses	4196 (96.2)	3607 (95.5)	2270 (85.4)	8027 (80.1)	497 084 (86.2)	515 184
Sweden born by foreign born	913	481	506	2127	99 376	103 403
Unvaccinated	<50 (<5)	<25 (<5)	96 (19.0)	623 (29.3)	20 605 (20.7)	21 391
1 dose	<25 (<3)	<10 (<2)	20 (3.9)	100 (4.7)	3407 (3.4)	3553
2 doses	850 (93.1)	451 (93.8)	390 (77.1)	1404 (66.0)	75 364 (75.8)	78 459
Born within EU	1846	291	420	1679	115 733	119 969
Unvaccinated	236 (12.8)	<50 (<16)	<100 (<24)	587 (35.0)	53 172 (45.9)	54 141
1 dose	38 (2.1)	<10 (<4)	<20 (<4)	77 (4.6)	4532 (3.9)	4671
2 doses	1572 (85.2)	236 (81.1)	305 (72.6)	1015 (60.4)	58 029 (50.1)	61 157
Born outside EU	1510	388	2364	6479	172 592	183 333
Unvaccinated	<150 (<10)	<50 (<12)	436 (18.4)	1806 (27.9)	55 569 (32.2)	58 005
1 dose	<50 (<3)	<10 (<2)	142 (6.0)	417 (6.4)	9491 (5.5)	10 097
2 doses	1318 (87.3)	339 (87.4)	1786 (75.6)	4256 (65.7)	107 532 (62.3)	115 231
<b>Women</b>						
Sweden born by Sweden born	6152	26 333	29 777	28 123	476 989	567 374
Unvaccinated	109 (1.8)	945 (3.6)	2969 (10.0)	4197 (14.9)	42 264 (8.9)	50 484
1 dose	141 (2.3)	586 (2.2)	900 (3.0)	980 (3.5)	11 919 (2.5)	14 526
2 doses	5902 (95.9)	24 802 (94.2)	25 908 (87.0)	22 946 (81.6)	422 806 (88.6)	502 364
Sweden born by foreign born	1187	3380	4790	5284	83 328	97 969
Unvaccinated	51 (4.3)	248 (7.3)	764 (16.0)	1215 (23.0)	14 946 (17.9)	17 224
1 dose	37 (3.1)	105 (3.1)	200 (4.2)	241 (4.6)	2943 (3.5)	3526
2 doses	1099 (92.6)	3027 (89.6)	3826 (79.9)	3828 (72.4)	65 439 (78.5)	77 219
Born within EU	2500	2353	5729	5575	92 522	108 679
Unvaccinated	275 (11.0)	350 (14.9)	1388 (24.2)	2026 (36.3)	35 187 (38.0)	39 226
1 dose	69 (2.7)	74 (3.1)	254 (4.4)	286 (5.1)	4106 (4.4)	4789
2 doses	2156 (86.2)	1929 (82.0)	4087 (71.3)	3263 (58.5)	53 229 (57.5)	64 664
Born outside EU	1168	2369	12 413	13 521	157 839	187 310
Unvaccinated	110 (9.4)	272 (11.5)	2245 (18.1)	3528 (26.1)	42 751 (27.1)	48 906
1 dose	30 (2.6)	114 (4.8)	822 (6.6)	985 (7.3)	9191 (5.8)	11 142
2 doses	1028 (88.0)	1983 (83.7)	9346 (75.3)	9008 (66.6)	105 897 (67.1)	127 262

occupational risk of SARS-CoV-2 exposure [18,19]. In an effort to increase vaccination coverage, multilingual information campaigns and mobile vaccination centres have been implemented in Sweden to target residential areas with a large proportion of immigrants and a low vaccine coverage.

The higher proportion of SARS-CoV-2 positive tests in 2020 among both foreign-born HCW and non-HCW compared to Sweden-born may reflect inequalities in health. Foreign-born have through their living and working conditions a higher exposure and susceptibility to SARS-CoV-2 as well as a higher risk of more severe consequences of the disease leading to a higher disease burden [20]. Hence, a SARS-CoV-2 infection in foreign-born might more often lead to the need of healthcare treatment and thus result in a positive test. In contrast, obstacles to health-seeking behaviour faced by non-Swedish-speaking immigrants may have led to that they failed to get tested, and may thus not have isolated themselves, aiding transmission at home and work. However, in 2021, testing have been free and widely available, thus detection bias would probably not fully explain the higher proportion of SARS-CoV-2 positive among foreign-born persons. Instead, socioeconomic factors such as crowded living conditions with difficulties to follow recommendations of social distancing, a higher rate of transmission in the residential area and dependency on public transportation may increase the risk of exposure to the virus and could together with a lower vaccination coverage contribute to a

higher transmission of SARS-CoV-2, which may in turn exacerbate existing inequalities in health.

The strengths of this study include the nationwide coverage of the whole population aged 35–64 years, the wide range of healthcare occupations, by information on region of birth, and mandatory reporting of SARS-CoV-2 vaccinations and SARS-CoV-2 positive tests to nationwide registers. One limitation is that information on occupation was obtained as of the status in November 2018 and some individuals may have changed occupation since then. This probably foremost affects those with shorter education, nurse aides followed by licensed practical nurses; hence vaccination coverage might be underestimated in these groups as the denominator probably is slightly overestimated compared to those still working as nurse aides in 2021. Also, despite being registered in Sweden, it may be a larger proportion of foreign-born than Sweden-born residing abroad or who moved abroad during the pandemic, or simply spent their vacation in their country of origin and might thus have been vaccinated abroad which is unknown to the Swedish national vaccination register. Hence, vaccine coverage might be underestimated in foreign-born and probably foremost among those born within EU who have easier access to their country of origin. However, all HCW employed within the healthcare services were offered vaccination early spring 2021. We have not assessed whether HCW who previously had been tested positive for SARS-CoV-2 to a lower or higher degree have chosen to get vaccinated.

**Table 4**

Proportion healthcare workers with positive test for SARS-CoV-2 in 2020 and 2021, by country of birth, aged 35–64, Positive test status as of 31st October 2021.

	Healthcare worker				Non-healthcare workers	Total
	Physician N (%)	Registered Nurse N (%)	Licensed practical nurse N (%)	Nurse aide N (%)	N (%)	N
<b>Men</b>						
Sweden born by Sweden born	7594	6440	5603	19 852	1 222 589	1 262 078
COVID-19 2020	906 (11.9)	876 (13.6)	719 (12.8)	1430 (7.2)	58 196 (4.8)	62 127
COVID-19 2021	483 (6.4)	453 (7.0)	400 (7.1)	1498 (7.6)	101 429 (8.3)	104 263
Sweden born by foreign born	1529	840	910	3730	191 285	198 294
COVID-19 2020	188 (12.3)	122 (14.5)	118 (13.0)	281 (7.5)	10 130 (5.3)	10 839
COVID-19 2021	115 (7.5)	52 (6.2)	73 (8.0)	294 (7.9)	16 207 (8.5)	16 741
Born within EU	3109	582	852	3443	209 192	217 178
COVID-19 2020	354 (11.4)	90 (15.5)	136 (16.0)	300 (8.7)	10 090 (4.8)	10 970
COVID-19 2021	211 (6.8)	36 (6.2)	74 (8.7)	330 (9.6)	17 281 (8.3)	17 932
Born outside EU	2700	726	4024	10 477	26 6310	284 237
COVID-19 2020	409 (15.2)	132 (18.2)	641 (15.9)	1066 (10.2)	16 588 (6.2)	18 836
COVID-19 2021	220 (8.2)	59 (8.1)	367 (9.1)	995 (9.5)	24 368 (9.2)	26 009
<b>Women</b>						
Sweden born by Sweden born	9370	53 824	80 190	67 418	998 738	1 209 540
COVID-19 2020	1038 (11.1)	6189 (11.5)	9614 (12.0)	4766 (7.1)	52 305 (5.2)	73 912
COVID-19 2021	624 (6.7)	4036 (7.5)	6135 (7.6)	5374 (8.0)	85 412 (8.6)	101 581
Sweden born by foreign born	1672	6766	11 393	11 254	159 087	190 172
COVID-19 2020	215 (12.9)	847 (12.5)	1338 (11.7)	804 (7.1)	9049 (5.7)	12 253
COVID-19 2021	126 (7.5)	522 (7.7)	939 (8.2)	935 (8.3)	13 982 (8.8)	16 504
Born within EU	4107	4993	13 379	11 981	173 928	208 388
COVID-19 2020	413 (10.1)	659 (13.2)	2054 (15.4)	1077 (9.0)	9361 (5.4)	13 564
COVID-19 2021	268 (6.5)	401 (8.0)	1366 (10.2)	1175 (9.8)	15 702 (9.0)	18 912
Born outside EU	1943	4168	21 080	21 567	242 920	291 678
COVID-19 2020	241 (12.4)	679 (16.3)	3604 (17.1)	2332 (10.8)	15 595 (6.4)	22 451
COVID-19 2021	141 (7.3)	356 (8.5)	1989 (9.4)	2142 (9.9)	23 788 (9.8)	28 416

The general recommendation in Sweden at the time was to get vaccinated even if you had had a verified SARS-CoV-2 infection.

In conclusion, vaccine coverage among physicians and registered nurses is very high. It is lower among licensed practical nurses and nurse aides, for some groups even lower than in non-HCW which is probably explained by a lower socioeconomic position among nurse aides. In all HCW groups Sweden-born had higher vaccination coverage than foreign-born. The difference in vaccine coverage by region of birth among HCW puts them at great occupational hazard and increase the risk of nosocomial transmission, regardless of whether an effect of socioeconomic inequalities or sociocultural beliefs. Further in-depth studies are warranted of reasons for non-vaccination among groups born outside Sweden, in order to inform strategies to increase vaccination, which should include involvement of the groups currently having lower vaccine coverage.

## 5. Disclosure statement

R.L. is employed at the Swedish Medical Products Agency, SE-751 03 Uppsala, Sweden. The views expressed in this paper do not necessarily represent the views of this Government agency.

## Ethical approval

The study is approved by the Swedish Ethical Review Authority (2020-06859, 2021-02186).

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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