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Short communication

The early impact of vaccination against SARS-CoV-2 in Region Stockholm, Sweden

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ABSTRACT

Vaccination against SARS-CoV-2 started in Region Stockholm, Sweden in December 2020 with those in long-term care facilities or receiving home care vaccinated first followed by those aged over 80 years. In this population-based, retrospective cohort study, we performed a Poisson regression to model the expected incidence of infections and deaths which we compared to the observed incidence and compared this to an unvaccinated control group of those aged 18–79 years. The aim of this study was to measure the early impact of the vaccination programme in Region Stockholm.

Infections and deaths reduced substantially amongst the first two groups targeted for SARS-CoV-2 vaccination with an estimated total 3112 infections prevented, and 854 deaths prevented in these two groups from 4 weeks after the introduction of vaccination through to 2nd May 2021.

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1. Introduction

The Swedish COVID-19 vaccination programme prioritises those most at risk of severe disease from SARS-CoV-2 infection first, with the aim of protecting those most vulnerable and safeguarding the healthcare system. The programme is divided into four phases: (1) adults living in long-term care facilities (LTCF), adults receiving home care and their household contacts, and healthcare staff working with this population, (2) adults over the age of 65 years as well as adults of any age who receive dialysis or are transplant recipients, with the oldest invited for vaccination first, (3) adults with other risk factors, (4) adults without risk factors. In Stockholm, vaccination of Phase 1 began on 27th December and vaccination of Phase 2 started on 8th March 2021 with adults ≥ 80 years invited for vaccination first [2]. Adults ≥ 75 years were invited starting on 29th March 2021 [2,3].

To assess the early impact of the vaccination programme in Stockholm, we performed a population-based, retrospective cohort study to investigate the incidence of PCR-confirmed SARS-CoV-2 as well as deaths within 30 days of a PCR-confirmed SARS-CoV-2 diagnosis, in the cohorts targeted for vaccination compared to a control group not targeted for vaccination.

2. Methods

2.1. Study population

The Stockholm COVID-19 cohort study collects data from all residents living in Region Stockholm from 2015 onwards. We extracted data from the VAL database which collates information from more than ten other healthcare related databases in Region Stockholm and which has been previously described [4]. Age, and coding for resident in LTCF and home care were used to define the two groups first targeted for vaccination, those in LTCF/home care and those aged ≥ 80 years, plus a third group, those aged 18–79 years who were used as a composite unvaccinated control. Linkage to SmiNet, the Public Health Agency of Sweden notifiable infection reporting tool, was performed using unique personal identification numbers that each resident in Sweden has, to extract data on SARS-CoV-2 PCR-positive cases.

The study was approved by the Swedish Ethical Review Authority.
2.2. Statistics

Analyses were restricted to 31st August 2020 to 2nd May 2021 in order to encompass the second and third waves of COVID-19 in Stockholm. Data from the first wave were not used given the lack of widely available testing at the start of the pandemic. Three mutually exclusive groups were defined, those in LTCF or receiving home care, those aged 80+ years and a composite control of those aged 18–79 years. The time point set for post-vaccination was 4 weeks after the start of vaccination, to account for the fact that the protective effect of a single dose of vaccine is not immediate and that not all individuals in the group will be vaccinated in the first week. Time up until 4 weeks after the vaccination campaign started was counted as pre-vaccination period. The pre-vaccination incidence rate ratio (IRR) between the three groups were estimated by Poisson regression based on the weekly incidences of cases (and deaths). Due to over dispersion the confidence intervals for the estimated IRRs were adjusted by a standard error inflation factor. The pre-vaccination IRRs (in relation to the composite control group) were used to prognosticate the post-vaccination incidence of infections (and deaths) in absence of vaccination, by multiplying the pre-vaccination IRRs with the observed post-vaccination incidence in the composite control group, using the confidence intervals of the pre-vaccination IRR to show uncertainty in the resulting estimate. Differences between the prognosticated and observed number of events were used to estimate the number of infections and deaths that may have been prevented up to 2nd May 2021 due to the vaccination programme. Aggregated data on vaccine coverage was grouped by age and residence in LTCF (home care status was not available).

Data was analysed using R version 4.1.0.

3. Results

A total 58,174 people (median age 80 years, IQR 71–87 years) were LTCF residents or receiving home care. In the 80+ group there were 62,306 people (median age 83 years, IQR 81–86 years) whilst in the group aged 18–79 there were 1,748,647 people (median age 44 years, IQR 32–58 years). The proportion of men was lower in the group aged 18–79 years. The time point set for post-vaccination was 4 weeks after the start of vaccination of the group. The vaccine coverage incidence in LTCF (home care status was not available).

### 3.1. Infections

The highest number of infections (182,695) were in the control group (18–79 year-olds) (Table 2). More infections were recorded in the LTCF/home care group (5769 total; 5232 pre-vaccination, 1537 post-vaccination) than in the 80+ group (2462 total; 2276 pre-vaccination, 186 post-vaccination). The IRR for SARS-CoV-2 infection in the LTCF/home care group was 1.70 (95% CI 1.54–1.88) pre-vaccination and 0.59 (0.49–0.71) post-vaccination compared to the composite control, higher than for the 80+ group which were 0.38 (0.33–0.44) pre-vaccination and 0.17 (0.09–0.27) post-vaccination (Table 2, Fig. 1A). Weekly observed versus expected incidences of infection per 100,000 days at risk are presented in Fig. 1A. The estimated number of infections prevented by vaccination was 2873 (2441–3337) for the LTCF/home care group and 239 (178–306) for the 80+ group (Table 2).

### 3.2. Mortality

More deaths within 30 days of a positive SARS-CoV2 PCR test were recorded in the LTCF/home care groups than in the 80+ group during the study period (1218 vs 244) (Table 3). In both groups the majority of deaths occurred prior to the start of vaccination; in the LTCF/home care group there were 978 pre-vaccination and 240 post-vaccination whereas in the 80+ group there were 224 pre-vaccination and 20 post-vaccination. 348 deaths were recorded in the 18–79 group. The IRR for death within 30 days of a positive SARS-CoV2 PCR test decreased from 179 (95% CI 146–221) pre-vaccination to 45 (35–59) post-vaccination for the LTCF/home care group and from 20 (16–26) pre-vaccination to 9 (5–18) post-vaccination for the 80+ group, compared to the composite control (Fig. 1B). The estimated number of deaths prevented after vaccination was 808 (95% CI 615–1053) for the LTCF/home care group and 46 (32–64) for the 80+ group (Table 3, Fig. 1B). Weekly observed versus expected incidence for deaths are presented in Fig. 1B.

### 3.3. Vaccine coverage and choice of vaccines in Stockholm

Fig. 1C and 1D show the vaccine coverage with doses 1 and 2 stratified by LTCF, age 80+ and ages 18–79. In both the LTCF and 80+ group, at least 80% of the group had received a first dose by 4 weeks after the start of vaccination of the group. The vaccine coverage data was based on LTCF and age, since data for those receiving home care was not available by vaccine status.
4. Discussion

Our data suggests that vaccination of the LTCF/home care and 80+ groups succeeded in preventing a third wave in these groups of the same magnitude as the control group. Since the start of the vaccination programme there has been no national lock-down or increase in restrictions to visiting friends and relatives in LTCF and as such the effect of prevention of infections and deaths is likely to be due to vaccination rather than to new social distancing measures alone [5]. The IRR for infections and deaths was much lower in the 80+ group compared to the LTCF/home care group even prior to vaccination, which is likely to be an effect of the Swedish recommendations, that is, that those over 70 years take extra precautions to avoid social contact with others outside their own household [6]. Those receiving home care who have regular visits by healthcare professionals and those living in LTCF have not been able to isolate to the same extent and have been much more vulnerable to the spread of infection [7].

A combination of EU approved vaccines has been used since the start of the programme. Use of the Pfizer-BioNTech mRNA vaccine started on 27th December 2020 followed by the Moderna mRNA vaccine after it received EMA approval on 6th January 2021 [8]. Astra-Zeneca’s COVID-19 vaccine received EMA approval on 29th January 2021 [8] although vaccination of those over 65 years with Astra-Zeneca’s vaccine only started on 4th March due to initial concerns about effectiveness in older adults [9]. Vaccination with Astra-Zeneca’s vaccine was paused between 16th and 25th March whilst reports of links with a rare blood clotting disorder were investigated [3]. Since 25th March, vaccination with Astra-Zeneca’s vaccine has been resumed amongst those over 65 [3,10,11]. It is likely therefore that the majority of those vaccinated in the LTCF/home care and 80+ groups received mRNA vaccines although data on the exact proportions was unavailable to the authors.

The effect observed is a combination of protection from a single dose and two doses. High vaccine coverage by 4 weeks post-vaccination was achieved in both of the first groups targeted for vaccination. Timing of the second dose of vaccinations has varied in Stockholm based on which vaccine is given and time point during the vaccination programme. At the time this study was conducted, the mRNA vaccines were given with a 3–7 week dosing interval and Astra-Zeneca’s vaccine with a 6–12 week interval [12].

Fig. 1. A. Weekly incidence of SARS-CoV-2 infection per 100,000 days at risk by group observed and estimated in the absence of vaccination (LTCF/home care, 80+, 18–79). B. Weekly deceased per 100,000 days at risk by group observed and estimated in the absence of vaccination (LTCF/home care, 80+, 18–79). C. Vaccine coverage with dose 1 by group (LTCF only, 80+, 18–79). D. Vaccine coverage with dose 2 by group (LTCF only, 80+, 18–79).
During the study period the predominant Sars-CoV2 variants circulating in Stockholm were initially non-Variants of Concern (VOC) i.e. wildtype SARS-CoV-2 in 2020 until the beginning of 2021 when the Alpha-VOC started to increased and became the dominant variant by early spring 2021. Between weeks 12–16 in 2021 the Alpha-VOC accounted for 87–95% of cases of Sars-CoV2 infection in Stockholm [13]. The Delta-VOC was not widely circulating at any point during the study period and first started to increase in prevalence from week 22 overtaking the Alpha-VOC by week 26 in 2021 [14].

This study was limited to programmatic effect in that we were unable to link individual level vaccine data as has recently been done in Israel [15] however little has yet been published on the impact of programmes using heterologous vaccines such as this one which is one of the studies strengths. A recent internal report from Public Health England estimates 10,400 deaths were prevented in England in the first 4 months of their COVID-19 vaccination programme using non-individual level data [16]. The advantage of before and after studies is that they take into account both the direct and indirect effects of vaccination. Yet, the assumption is that everything remains constant pre- and post-vaccination time. The overall trend, however, following initiation of vaccination is highly encouraging.

In conclusion, the programmatic early effects of vaccination in two of the most vulnerable groups are both reduced SARS-CoV-2 infections and deaths.

**Authorship**

All authors have seen and approved the manuscript and contributed significantly to the work. PN devised the study, CI wrote the manuscript and contributed to the analysis, DS performed the main analysis, FG assisted with statistical analyses and MPH provided the vaccination data.

**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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