Journal Pre-proof

Investigating the association between COVID-19 vaccination and care home outbreak frequency and duration

Declan T. Bradley, Siobhán Murphy, Paul McWilliams, Sarah Arnold, Siobhán Lavery, Joanne Murphy, Simon de Lusignan, Richard Hobbs, Ruby S.M. Tsang, Ashley Akbari, Fatemeh Torabi, Jillian Beggs, Antony Chuter, Ting Shi, Eleftheria Vasileiou, Chris Robertson, Aziz Sheikh, Director, Heather Reid, Dermot O'Reilly

Please cite this article as: Bradley DT, Murphy S, McWilliams P, Arnold S, Lavery S, Murphy J, de Lusignan S, Hobbs R, Tsang RSM, Akbari A, Torabi F, Beggs J, Chuter A, Shi T, Vasileiou E, Robertson C, Sheikh A, Reid H, O'Reilly D, Investigating the association between COVID-19 vaccination and care home outbreak frequency and duration, *Public Health*, https://doi.org/10.1016/j.puhe.2021.12.010.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Investigating the association between COVID-19 vaccination and care home outbreak frequency and duration

Authors

Declan T. Bradley, Public Health Agency, Belfast, UK; Centre for Public Health, Queen's University Belfast, Belfast, UK.

Siobhán Murphy, Centre for Public Health, Queen's University Belfast, Belfast, UK.

Paul McWilliams, Strategic Investment Board, Belfast, UK

Sarah Arnold, Public Health Agency, Belfast, UK.

Siobhán Lavery, Public Health Agency, Belfast, UK.

Joanne Murphy, Public Health Agency, Belfast, UK.

Simon de Lusignan, Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK

Richard Hobbs, Nuffield Department of Health Care Sciences, University of Oxford, Oxford, UK.

Ruby S. M. Tsang, Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK.

Ashley Akbari, Population Data Science and Health Data Research UK, Swansea University, Swansea, UK

Fatemeh Torabi, Population Data Science, Swansea University Medical School, UK

Jillian Beggs, The Health Data Research Hub for Respiratory Health, Edinburgh, UK

Antony Chuter, The Health Data Research Hub for Respiratory Health, Edinburgh, UK

Ting Shi, Usher Institute, University of Edinburgh, Edinburgh, UK.

Eleftheria Vasileiou, Usher Institute, University of Edinburgh, Edinburgh, UK.

Chris Robertson, Public Health Scotland, UK; University of Strathclyde, Glasgow, UK

Aziz Sheikh, Usher Institute, University of Edinburgh, Edinburgh, UK and Director, HDR UK BREATHE Hub.

Heather Reid, Public Health Agency, Belfast, UK.

Dermot O'Reilly, Centre for Public Health, Queen's University Belfast, Belfast, UK.

Corresponding author: Siobhán Murphy siobhan.murphy@qub.ac.uk

Centre for Public Health, Queen's University Belfast, Belfast, UK.

Word count 3,711 (excl Abstract and references)

1 Abstract

2 Objectives

3 At the end of 2020, many countries commenced a vaccination programme against
4 SARS-CoV-2. Public health authorities aim to prevent, and interrupt, outbreaks of
5 infectious disease in social care settings. We aimed to investigate the association
6 between the introduction of the vaccination programme and the frequency and
7 duration of COVID-19 outbreaks in Northern Ireland (NI).

8 Study Design

9 We undertook an ecological study using routinely available national data.

10 Methods

11 We used Poisson regression to measure the relationship between the number of RT-
12 PCR confirmed COVID-19 outbreaks in care homes and, as a measure of
13 community COVID-19 prevalence, the Office for National Statistics COVID-19
14 Infection Survey estimated number of people testing positive for COVID-19 in NI. We
15 estimated the change in this relationship and estimated the expected number of care
16 home outbreaks in the absence of the vaccination programme. A Cox proportional
17 hazards model estimated the hazard ratio of a confirmed COVID-19 care home
18 outbreak closure.

19 Results

20 Care home outbreaks reduced by two-thirds compared to expected following the
21 introduction of the vaccination programme, from a projected 1,625 COVID-19
22 outbreaks (95% prediction interval 1,553 – 1,694) between 7 December 2020 and 28
23 October 2021 to an observed 501. We estimated an adjusted hazard ratio of 2.53 of
24 the outbreak closure assuming a 21-day lag for immunity.

25 Conclusions

26 These findings describe the association of the vaccination with a reduction in
27 outbreak frequency and duration across NI care homes. This indicates probable
28 reduced harm and disruption from COVID-19 in social care settings following
29 vaccination. Future research using individual level data from care home residents will
30 be needed to investigate effectiveness of the vaccines and the duration of their
31 effects.

32 Keywords

33 COVID-19; SARS-CoV-2; Care Homes; Outbreak; Vaccination

1 Introduction

2 COVID-19 has caused a disproportionately high number of deaths among the
3 residents of care homes in the UK[1]; an experience shared by other countries.[2-5] In
4 Northern Ireland (NI), there have been 1,127 COVID-19-related deaths among care
5 home residents by the week ending 5 November 2021[6]. Care home residents may
6 be at high risk of exposure to SARS-CoV-2 because of outbreaks in these closed
7 settings and greater vulnerability to severe outcomes because of age and
8 comorbidities.[2,3] A range of factors contribute to the risk, size and duration of
9 outbreaks in care homes, including the background community incidence of
10 infection, the prevalence of infection in care home staff, care home size, the use of
11 bank and agency staff, regional variation and whether homes provided sick pay to
12 their staff.[5,7] Though comparison of mortality rates across different stages of the
13 pandemic is difficult, international evidence demonstrates a lower level of excess
14 deaths among care home residents in the second wave of the pandemic.[8] This
15 suggests that the enhancement of infection prevention and control measures
16 including the restriction of visiting, cohorting of staff and/or the increased testing of
17 staff and residents may have reduced transmission compared to the earlier period,
18 though there may also have been some displacement of the timing of deaths,
19 bringing deaths forwards in time during the first wave.

20 In light of the exposure and vulnerability of care home residents to SARS-CoV-2, the
21 UK Joint Committee on Vaccination and Immunisation recommended that residents
22 and staff of care home should the first group to be offered vaccination when it
23 became available in late 2020.[9] On 8 December 2020, Health and Social Care
24 (HSC) Trusts (public healthcare providers) began a vaccination programme for staff
25 and residents in care homes in NI. The programme primarily used Pfizer BioNTech
26 COVID-19 mRNA Vaccine BNT162b2 (with a small number of exceptions for *ad hoc*
27 doses of the AstraZeneca COVID-19 vaccine given to those who missed vaccination
28 at the time of the visit to the care home by those delivering the vaccination
29 programme). In contrast to the other parts of the UK, NI delivered the great majority
30 of the care home vaccination programme with a 21-day interval between doses, as
31 most implementation occurred before the change in policy to a 12-week dosing
32 interval, which was announced on 31 December 2020. In advance of individual-level
33 data being available, we sought to investigate the association between the COVID-
34 19 vaccination programme on COVID-19 outbreak frequency and duration. The
35 vaccination programme was introduced at a time when there were changes in non-
36 pharmaceutical interventions (including a period of 'lockdown') in NI, which were
37 associated with considerable changes in the growth of the epidemic. Investigation of
38 the association between the vaccination programme and changes in COVID-19
39 outcomes therefore needed to use methods that would not be confounded by this
40 changing context. The aim of our study was to assess the association of the COVID-
41 19 vaccine programme and the frequency and duration of confirmed COVID-19
42 outbreaks in care homes.

1 **Methods**

2 **Research ethics**

3 This study was undertaken using routine data, accessed under pre-existing
4 information governance arrangements, for the purpose of health protection
5 surveillance, and for health and social care service delivery and evaluation.
6 Research ethics approval was not required.

7 **Study population**

8 There were 480 operational care homes in NI on 18 November 2021 (Table 1).[10]
9 Care home occupancy is dynamic over time, though occupancy is high. The majority
10 of homes were independent, with some were directly operated by HSC Trusts.

11 Table 1. Number and size of care homes registered in NI on 18 November 2021.

Care home type	Number	Maximum approved places
Residential	235	5,344
Nursing	245	10,710
Total	480	16,054

12

13 **Definitions**

14 *Possible case of COVID-19*

15 Any resident (or staff) with symptoms of COVID-19 (high temperature, new
16 continuous cough or loss of taste/smell), or new onset of influenza-like illness or
17 worsening shortness of breath. Symptoms may be more nuanced in older people
18 with co-morbidities in care homes who may present with Flu Like Illness (FLI),
19 respiratory illness, new onset confusion, reduced alertness, reduced mobility, or
20 diarrhoea and sometimes do not develop fever. This may be true for COVID-19, so
21 such changes should alert staff to the possibility of new COVID infection

22 *Confirmed case of COVID-19*

23 Any resident (or staff) with Reverse Transcription Polymerase Chain Reaction (RT-
24 PCR) laboratory-confirmed diagnosis of COVID-19.

25 *COVID-19 outbreak*

26 Two or more cases in a facility which meet the case definition of a possible or
27 confirmed case of COVID-19, within a 14-day period among either residents or staff
28 in the care home

29 *Confirmed COVID-19 outbreak*

30 Identification of two or more confirmed COVID-19 cases (both symptomatic and
31 asymptomatic detection), among either residents or staff in the care home, within a
32 14-day period.

33 *Closed outbreaks*

3

1   An outbreak was closed when there have been no new cases for 14 days after
2   symptom onset of most recent case and a terminal clean was complete.

3   **Data sources and preparation**

4   *Daily returns from care homes to the Regulation and Quality Improvement Authority*

5   All care homes in NI participated in a monitoring scheme through which they
6   submitted daily aggregate data to the Regulation and Quality Improvement Authority
7   (RQIA). Summary information from these reports was made available to us in the
8   Public Health Agency (PHA). The submissions from each care home for the previous
9   calendar month, along with the maximum number of staff employed and number of
10   beds occupied during that month, were used to estimate of the number of staff and
11   residents for each care home.

12   *Care home outbreak surveillance*

13   The PHA health protection (HP) team was notified by care homes of cases of
14   COVID-19. An outbreak was declared when two or more cases among care home
15   residents or staff in a facility meet the case definition of a possible or confirmed case
16   of COVID-19 within a 14-day period, according to the definitions above.[11] Once an
17   outbreak was notified information was entered into the management information
18   system, HP Zone. Data was extracted from HP Zone by the HP surveillance team,
19   cleaned and entered into a database.

20   *Office for National Statistics (ONS) COVID-19 Infection Survey (CIS)*

21   The ONS CIS tests approximately 5,000 people for COVID-19 in NI over two-week
22   time windows, and provides openly available modelled estimates of the number of
23   people in NI who would test positive, if tested.[12] This is an estimate of community
24   prevalence of COVID-19, which does not include care homes or hospitals. Full
25   details of the survey methods are available from the ONS.[12] We used the 'Estimated
26   number of people testing positive for COVID-19' from 'Official reported estimates of
27   the percentage of the population testing positive for COVID-19, NI', from 17 October
28   2020 to 23 October 2020, to 31 October 2021 to 6 November 2021, which was the
29   full range of results available that used a consistent method.

30   **Testing practices**

31   A regular programme of COVID-19 testing (screening) for all care home residents
32   and staff in NI commenced on 3 August 2020. All asymptomatic residents were
33   tested for COVID-19 every 28 days and all asymptomatic staff were tested every 7
34   days with a RT-PCR test. Health and Social Care Trusts offered Loop-mediated
35   isothermal amplification (LAMP) tests for residents for whom RT-PCR testing was
36   unsuitable, but we were advised by the responsible team in PHA that this was used
37   very rarely. If a single case was identified through a positive test result, the whole
38   home was tested. Detailed guidance was provided to homes about the pattern of
39   testing during and after outbreaks.

40   **Statistical methods**

41   *Outbreak Frequency*

1   We used the ONS CIS estimated number of people testing positive for COVID-19 as
2   a measure of the severity of the epidemic in the general population. We explored the
3   relationship between this measure and the weekly frequency of new PCR-confirmed
4   COVID-19 care home outbreaks by plotting these in a scatter plot. We used *ccf* in R
5   v 4.0.2 for the cross-correlation function to assess for a time lag between the
6   variables, and applied the time lag associated with the maximum correlation before
7   fitting a Poisson regression model using *glm* in R v 4.0.2. We chose a Poisson model
8   because the dependent variable was a count of events, and the low value daily
9   counts of care home outbreaks did not meet the assumptions required for linear
10   regression. We divided the time series into a pre-vaccination period, before 7
11   December 2020, a 'washout' period from 7 December 2020 to 28 February 2021
12   inclusive, and a post-vaccination period from 1 March 2021 to 3 November 2021.
13   The majority of care homes had first vaccinations delivered during December 2020
14   (Figure S1). Staff and residents were offered vaccination at the same time. Those
15   that were in an outbreak at the time vaccination was due were deferred. By the end
16   of December 2020, at least 356 (74%) had their first dose, and by the end of January
17   2021, at least 404 (84%) had their first dose (for these estimates, any
18   incompleteness in reporting will bias the estimate downwards). This three-month
19   'washout' period conservatively allowed the great majority of care homes to have
20   been given two visits for vaccination (with the 21-day dosing interval), with time for
21   an immune response to the second dose. ONS CIS results were reported weekly as
22   midpoint estimates of the reported week, so we added three to the first day of the
23   reporting window to make the value represent the middle of the time period, and
24   interpolated daily estimates using *spline(method = "fmm")* in R v4.0.2. Poisson
25   generalized linear regression models were created for the pre- and post-vaccination
26   time periods separately, to investigate the relationship in each time period, then in a
27   single multivariable model with the pre-vaccination time period as the reference
28   category. This was conducted for all care homes, and for nursing and residential
29   homes separately. The expected number of care home outbreaks in the absence of
30   the vaccination programme was projected from the observed number of community-
31   acquired COVID-19 hospitalisations using *predict.glm* to estimate the daily and total
32   number of new care home outbreaks that would have been expected if the
33   conditions of the pre-vaccination time period had continued. The total projected
34   number of outbreaks for the time and its confidence limits were estimated by 1,000
35   simulations that used *rpois* for random daily projections, summing the projected
36   number of outbreaks in the time period for each simulation, and taking the median
37   and the 2.5% and 97.5% quantiles of the simulated total outbreak counts.

38   *Outbreak Closure*

39   A Cox proportional hazards model was used to produce the hazard ratios (HR) and
40   95% confidence intervals (CIs) to measure the hazard ratio for a care home COVID-
41   19 outbreak being declared over. The likelihood of an outbreak is known to be
42   directly related to care home size.[5,13] For this analysis, residents in each home
43   ranged from one to 100 and staff from three to 280. Community prevalence of
44   COVID-19 affects prevalence of the virus in care home settings.[13] To adjust for this,
45   the rolling 7-day prevalence of COVID-19 at Super Output Level (SOA) and care
46   home size were adjusted for in the model.

47   Each of the homes with a reported outbreak represented a case with the time since
48   first visit at which COVID-19 vaccination was administered to staff and/or residents

1 as the exposure and duration of outbreak as the outcome. The exposure time was
2 lagged by 21 days from the first visit to vaccinate the staff and residents to account
3 for the lead time from vaccination to immunity. The 21-day lag period was chosen as
4 a time point by which vaccine would be in effect (69% vaccine effectiveness at 14-20
5 days and 79% at 21-28 days after first dose in people aged 80 years or older).[14] A
6 Kaplan Meier plot was produced showing 'survival' of outbreaks by care home
7 vaccination status. The time lag was altered to 14, 28 and 35 days as a sensitivity
8 analysis for the Cox regression (which includes the time period of the second dose of
9 vaccine for most care homes). We considered only the effect of time from first
10 vaccine (rather than whether there was a second vaccine visit) as we had no way of
11 separating any changes associated with the passage of time from the first dose from
12 any change associated with a second dose. Most homes received their second visit
13 at 21 days, and the presence of an outbreak was a potential reason for the second
14 vaccine being delayed.

Results

Study population

17 The Northern Ireland Statistics and Research Agency (NISRA) estimated the
18 population of NI on 30 June 2019 to be 1,893,700, of which 38,700 (2%) were over
19 the age of 85.[15] Total care home residents and staff were estimated to be 12,884
20 and 20,537 respectively. Using aggregate data provided by RQIA as of 8 April 2021
21 the overall vaccination coverage for residents was estimated to be 11,608 (90.1%)
22 and 10,368 (80.5%) for first and second vaccines and 14,524 (70.7%) and 13,173
23 (64.1%) for staff respectively.

The frequency of COVID-19 outbreaks in care homes

25 There was a 7-day time lag between care home outbreaks and the estimated
26 number of people who would have tested positive in the community according to the
27 ONS CIS (Figure S2). The trends in care home outbreaks happened earlier than the
28 community prevalence. The association between the number of people who would
29 have tested positive and the daily number of new care home outbreaks with
30 confirmed COVID-19 is shown, adjusted for the 7-day time lag. The gradient of this
31 relationship was different in the pre-vaccination and post-vaccination time periods
32 (Figure 1). The pattern was the very similar in nursing and residential homes when
33 shown separately (Figures S3 and S4).
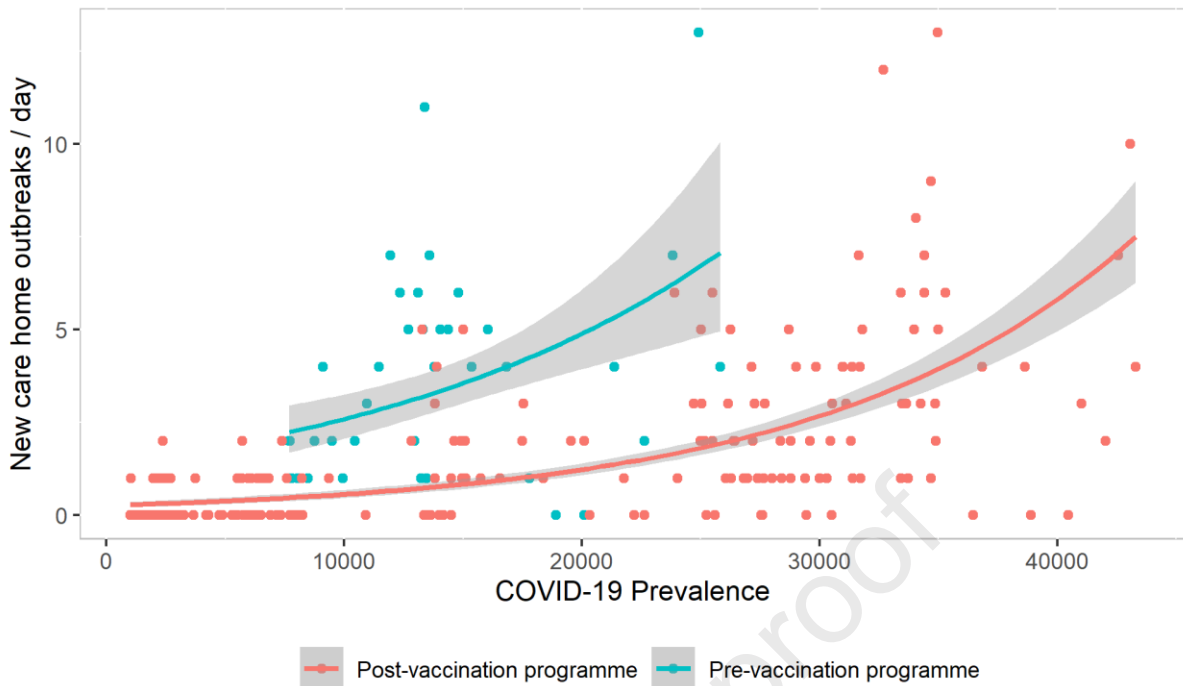
1

2   **Figure 1.** Number of people who would have tested positive for COVID-19 in the
3   Office for National Statistics COVID-19 Infection Survey (COVID-19 Prevalence) and
4   incident care home outbreaks per day pre- and post-vaccination programme.

5

6   Poisson regression models for the pre- and post-vaccination time periods are shown
7   (Table 1), illustrating a change in the relationship. A multivariable Poisson regression
8   model of the number of new care home outbreaks per day as the dependent
9   variable, and the modelled number of people who would have tested positive for
10 COVID-19 showed a significant association between the post-vaccination period and
11 reduced care home outbreaks (incidence rate ratio 0.28 (0.23-0.35)). When
12 investigated separately, nursing homes (IRR 0.27 (0.21-0.35)) and residential homes
13 (IRR 0.27 (0.19-0.40)) showed the same relative effect.

14 We used the relationship between the number of people who would have tested
15 positive for COVID-19 in the Office for National Statistics COVID-19 Infection Survey
16 and care home outbreaks from pre-vaccination period to project the number of
17 outbreaks expected in the washout and post-vaccination period. The projection
18 estimated 1,625 (95% prediction interval 1,553 – 1,694) outbreaks would occur
19 between 7 December 2020 and 28 October 2021 and we observed 501 outbreaks in
20 that time period. The observed and projected number of care home outbreaks are
21 shown as a time series (Figure 2).
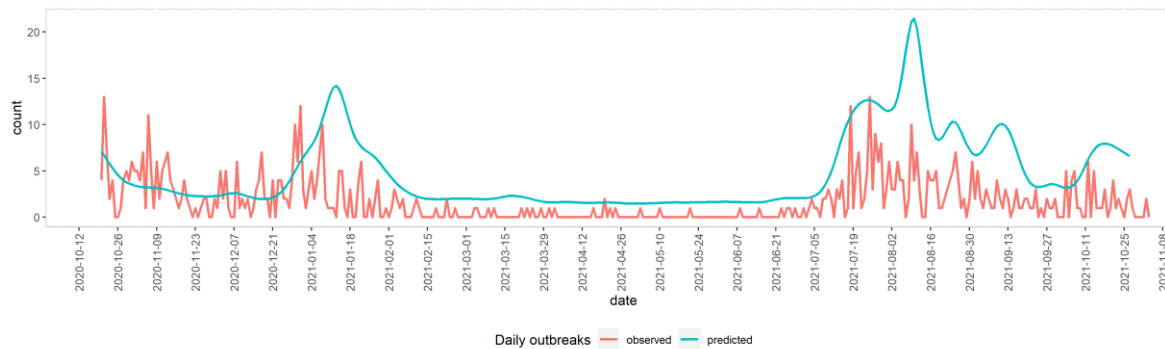
1

2 **Figure 2** Observed and predicted care home outbreaks per day.

3

4 **The duration of COVID-19 outbreaks in care homes**

5 We used a Cox proportional hazards model to investigate whether care homes that
6 had been offered the vaccination had a higher likelihood of outbreak closure than
7 those homes that had not reached that immunity threshold. Between 7 December
8 2020 to 8 April 2021 there were 179 confirmed COVID-19 outbreaks in care homes
9 following the first vaccination, 175 of which had ended at the time of analysis.
10 Median outbreak duration was 29 days from notification to closure (Table S1). A
11 Kaplan Meier plot illustrates the divergence of the outbreak duration in vaccinated
12 compared to unvaccinated care homes (Figure 3).
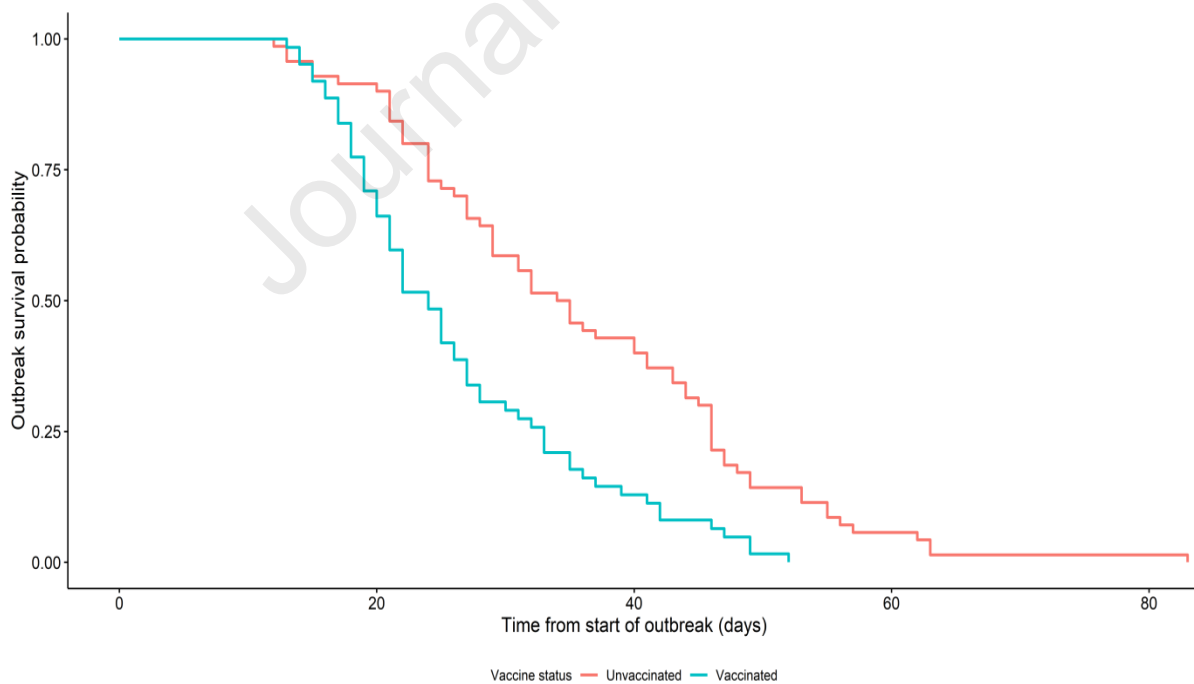
13

14 **Figure 3** Kaplan Meier plot illustrating survival of outbreaks by vaccination status.

15

16 The findings indicate that vaccinated homes had a significantly higher hazard ratio of
17 experiencing outbreak closure over time than homes in which the vaccination

8

1   programme had not yet been implemented (Table 2). These findings remain after
2   adjusting for care home size and measures of community prevalence of COVID-19.
3   The daily hazard ratios analysis illustrating the effect of using different time lags for
4   immunity from vaccination shows the effect days post-vaccination the likelihood of
5   outbreak closure increases and appears to stabilise by day 28 (Figure S5).

6

7   **Table 2**. Hazard ratios and 95% confidence intervals for outbreak closure in homes
8   according to time since first vaccination.

Time after vaccination	N (112)	Unadjusted Model		Adjusted Model*	
		HR (95% CI)	p	HR (95% CI)	p
14 days	79	2.22 (1.52-3.24)	<.001	2.44 (1.64-3.63)	<.001
21 days	62	2.24 (1.56-3.22)	<.001	2.53 (1.88-4.31)	<.001
28 days	42	2.57 (1.75-3.78)	<.001	2.84 (1.88-4.34)	<.001
35 days	32	2.27 (1.51-3.43)	<.001	2.55 (1.63-3.99)	<.001

9   Note: HR = hazard ratio; CI confidence interval; *= models adjusted for care home
10   size and community prevalence.

Discussion

12   The COVID-19 pandemic has had a severe impact on care home residents and staff
13   worldwide. Consequently, residents and staff were amongst the first groups to be
14   offered vaccination. Our findings suggest that the introduction of the COVID-19
15   vaccination programme in NI was associated with a two-thirds reduction in the
16   frequency of confirmed COVID-19 outbreaks in care homes compared to the
17   expected number. This relative effect was the same in nursing and residential
18   homes. We showed that the outbreak duration was shorter in homes where the
19   vaccine had been delivered. These findings provide evidence that the vaccination
20   programme had a positive impact on outbreaks in care homes.

21   Outbreaks occurred in the post vaccination period and there are many potential
22   explanations for this. Not all residents and staff will have been vaccinated, and not all
23   those vaccinated will have been fully protected against infection. Furthermore, the
24   care home population is dynamic, with new residents arriving, many of whom would
25   not have been vaccinated. The workforce is also dynamic, and staff may frequently
26   move between care homes and not all were vaccinated. The social care working
27   group of the Scientific Advisory Group for Emergencies (SAGE) have advised that in
28   order to protect against outbreaks in care homes vaccination uptake rates of 90% of
29   residents and 80% of staff are required.[16] As of 4 April 2021, 94% of all eligible
30   people living in older adult care homes and 78.9% of all eligible workers in all in
31   England have received at least their first vaccination.[16] This had led the English
32   Department of Health and Social Care to launch a consultation on COVID-19
33   vaccination as condition of work for people who work in care homes.[16] Other
34   jurisdictions can be expected to observe these developments with interest.

35   The findings of this study should be interpreted in the context of its methodological
36   limitations. We did not have access to individual vaccination status at the time of

1   writing and future work on individual level data will be needed to validate our
2   findings. We chose not to use aggregate counts of the number of individuals
3   vaccinated within homes, or the number of cases within outbreaks. Though these
4   aggregate data were reported and collected, we were advised by PHA that these
5   data were not suitable for statistical analysis due to variation in the completeness
6   and quality of these between and within homes, and over time. Therefore, we used
7   the dates of events, which were considered more robust. Outbreak dates were
8   recorded by PHA. We did not attempt to account for the potentially complex
9   interactions between past outbreaks, delays to vaccination, and the resulting
10   synergistic effects of vaccination on a background of recent infection, which would
11   reduce the chance of future outbreaks. This warrants deeper exploration in future.
12   Individual-level data would enable linkage across a range of administrative datasets
13   to assess the effectiveness of the vaccination programme against a range of
14   outcomes. Reliable information about whether individuals are in a specific care home
15   is elusive in administrative information systems and the challenges of accurately
16   identifying and following these individuals have been well-documented.[17-18] The
17   pandemic has also highlighted how investment in development of minimum dataset
18   for care home residents is needed to understand the health needs and outcomes of
19   this vulnerable population. The association between community prevalence and care
20   home outbreaks measured in the pre-vaccination status might be sensitive to the fact
21   that the ONS CIS data were not available for a period of very low community
22   prevalence. Though we did not aim to measure the incremental benefit of the second
23   dose that was delivered after a 21-day interval, there was no obvious increase at 28
24   or 35 days in sensitivity analyses, or in the estimates of hazard ratio with time
25   beyond 21 days in Figure S5. This might be explained by the wide confidence limits
26   (our study was not designed or powered to directly compare the effect of the second
27   to first doses), that infection prevention and control measures in place during this
28   period may have been sufficiently robust to mask the incremental benefit of the
29   second dose, or that the benefit of the first dose may give a level of protection due to
30   network effects that, at a group level, makes the effect of the second dose less
31   evident.

32   By the end of 2020, the UK Medicines and Healthcare products Regulatory Agency
33   (MHRA) approved two vaccines, Pfizer-BioNTech and Oxford-AstraZeneca, for
34   administration. The speed with which these vaccines were available has been
35   unprecedented. In the UK, as of 1 December 2021, 116 million COVID-10 vaccines
36   have been administered.[19] Public Health England recently reported that a single
37   dose of the Pfizer vaccine was approximately 60-70% effective at preventing
38   symptomatic disease which increased to approximately 85-90% following two doses
39   in over 70-year-olds.[20] For those vaccinated who later developed COVID-19 there
40   was a 44% lower risk of hospitalisation and a 51% lower risk of death compared to
41   unvaccinated people.[20] In looking specifically at care home residents, a large UK
42   cohort study of 10,400 residents reported vaccine effectiveness estimates of 62%
43   against PCR-confirmed infection following first vaccination.[21] Furthermore, a recent
44   preliminary study suggests that a single dose of vaccine may be sufficient to obtain a
45   high level of S-protein IgG antibody in nursing home residents previously diagnosed
46   with COVID-19.[22] Collectively, these findings are encouraging and demonstrate the
47   success of the vaccination programme in the early stages in reducing outbreaks
48   across NI care homes. This evidences a significant degree of protection among a
49   vulnerable and at-risk population against the severe consequences of COVID-19.

Future research using individual level data and across longer periods post
vaccination will be needed to determine the magnitude and duration of this
protection.

References

1. Schultze A, Nightingale E, Evans D et al. R. Mortality among Care Home
   Residents in England during the first and second waves of the COVID-19
   pandemic: an analysis of 4.3 million adults over the age of 65. MedRxiv
   2021.

2. Salcher-Konrad M, Jhass A, Naci H et al. COVID-19 related mortality and
   spread of disease in long-term care: a living systematic review of
   emerging evidence. MedRxiv 2020.

3. Comas-Herrera A, Zalakaín J, Litwin C et al. *Mortality associated with
   COVID-19 outbreaks in care homes: Early International
   Evidence.* Retrieved from https://alzheimeriberoamerica.org/wp-
   content/uploads/2020/04/Mortality-associated-with-COVID-12-April-3.pdf

4. Morciano M, Stokes J, Kontopantelis E et al. Excess mortality for care
   home residents during the first 23 weeks of the COVID-19 pandemic in
   England: a national cohort study. *BMC Med* 2021;19: 1-11.

5. Burton JK, Bayne G, Evans C et al. Evolution and effects of COVID-19
   outbreaks in care homes: a population analysis in 189 care homes in one
   geographical region of the UK. *Lancet Healthy Longev* 2020; 1:e21-e31.

6. Northern Ireland Statistics and Research Agency (NISRA) 2021. Weekly
   deaths in Northern Ireland. Retrieved from
   https://www.nisra.gov.uk/system/files/statistics/Deaths-Registered-in-NI-
   Week-44-2021.pdf

7. Office of National Statistics. *Impact of coronavirus in care homes in
   England: 26 May to 19 June* 2020. Retrieved from
   https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialca
   re/conditionsanddiseases/articles/impactofcoronavirusincarehomesinengla
   ndvivaldi/26mayto19june2020

8. Ioannidis JP, Axfors C, Contopoulos-Ioannidis DG. Second versus first
   wave of COVID-19 deaths: shifts in age distribution and in nursing home
   fatalities. *Environ Res* 2021; 195:110856. DOI
   10.1016/j.envres.2021.110856

9. Joint Committee on Vaccination and Immunisation: advice on priority groups for COVID-19 vaccination 2020. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/950113/jcvi-advice-on-priority-groups-for-covid-19-vaccination-30-dec-2020-revised.pdf

10. The Regulation and Quality Improvement Authority: Services registered with RQIA. Retrieved from https://www.rqia.org.uk/what-we-do/register/services-registered-with-rqia/. Accessed 18 November 2021.

11. Public Health England 2020. COVID-19: epidemiological definitions of outbreaks and clusters in particular settings. Retrieved from

https://www.gov.uk/government/publications/covid-19-epidemiological-definitions-of-outbreaks-and-clusters/covid-19-epidemiological-definitions-of-outbreaks-and-clusters-in-particular-settings

12. Office for National Statistics. Coronavirus (COVID-19) Infection Survey, UK 12 November 2021. Retrieved from https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/coronaviruscovid19infectionsurveypilot/12november2021

13. Abrams HR, Loomer L, Gandhi A et al. Characteristics of US nursing homes with COVID-19 cases. *J Am Geriatr Soc 2020;68:*1653-1656.

14. Vasileiou E, Simpson CR, Shi T, et al. Interim findings from first-dose mass COVID-19 vaccination roll-out and COVID-19 hospital admissions in Scotland: a national prospective cohort study. *Lancet*. 2021 May 1;397(10285):1646-1657. doi: 10.1016/S0140-6736(21)00677-2.

15. Northern Ireland Statistics and Research Agency (NISRA) 2020. 2019 Mid-year Population estimates for Northern Ireland. Retrieved from

https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/MYE19-Bulletin.pdf

16. Department of Health and Social Care. Making vaccination a condition of deployment in older adult care homes. Retrieved from https://www.gov.uk/government/consultations/making-vaccination-a-condition-of-deployment-in-older-adult-care-homes

17. Burton JK, Goodman C, Guthrie B et al. Closing the UK care home data gap–methodological challenges and solutions: Closing the UK care home data gap. *Int J Popula Data Sci 2020*: https://doi.org/10.23889/ijpds.v5i4.1391

18. Housley G, Lewis S, Usman, et al. Accurate identification of hospital admissions from care homes; development and validation of an automated algorithm. Age Ageing 2018; 47:387-391.

19. UK Government: Coronavirus (COVID-19) in the UK. Retrieved from https://coronavirus.data.gov.uk/details/vaccinations

20. Bernal JL, Andrews N, Gower C et al. Early effectiveness of COVID-19 vaccination with BNT162b2 mRNA vaccine and ChAdOx1 adenovirus vector vaccine on symptomatic disease, hospitalisations and mortality in older adults in England. MedRxiv 2021.

https://www.medrxiv.org/content/medrxiv/early/2021/03/02/2021.03.01.212
52652.full.pdf

21. Shrotri, M, Krutikov M, Palmer T et al. Vaccine Effectiveness of the First
Dose of ChAdox1 nCOV-19 and BNT162b2 Against SARS-CoV-2
Infection in Residents of Long Term Care Facilities (VIVALDI Study).
MedRxiv 2021. http://dx.doi.org/10.2139/ssrn.3814794

22. Blain H, Tuaillon E, Gamon L, et al. Spike Antibody Levels of Nursing
Home Residents With or Without Prior COVID-19 3 Weeks After a Single
BNT162b2 Vaccine Dose. *JAMA* 2021:
http://dx.doi.org/10.1001/jama.2021.6042