Public Health England

Protecting and improving the nation's health

PHE monitoring of the early impact and effectiveness of COVID-19 vaccination in England

22 February 2021

Contents

Introduction

Vaccination against COVID-19 commenced in England on 8th December 2020, initially using the Pfizer BioNTech mRNA vaccine. The AstraZeneca vaccine was then added to the programme from 4th January 2021.

The target groups for vaccination followed the Joint Committee on Vaccination and Immunisation (JCVI) prioritisation (1) and so residents and staff of care homes for the elderly, individuals over the age of 80 years and health and social care workers were the first to receive vaccination, initially through hospital hubs.

Vaccination then became available through mass vaccination centres, local vaccination centres run by primary care networks, and general practices and pharmacies. Roving delivery to care homes commenced from the 14th December. Extension of the programme to those aged over 75 and then 70 years, plus individuals in the Clinically Extremely Vulnerable group followed. By 15th February 2021, everyone in these priority groups had been offered the first dose of vaccination.

Surveillance objectives

PHE will be monitoring the effectiveness of COVID-19 vaccines against the following outcomes (2):

- virologically confirmed symptomatic disease using PCR
- hospitalisation
- mortality
- laboratory confirmed infection (symptomatic or asymptomatic) using PCR or by demonstrating seroconversion due to disease
- markers of infectiousness and transmissibility - viral load (CT value) and culturable virus
- onwards person to person transmission

Surveillance data sources

Routine testing

Community based testing for COVID-19 (referred to as Pillar 2),(3) is available for individuals with coronavirus symptoms (high temperature, new continuous cough, loss or change in sense of smell or taste) or if they are part of a local or national testing programme.

Vaccination information

The National Immunisation Management System (NIMs) includes demographic data for the adult population of England extracted from GP registration. NIMs is being used to invite people for vaccination and individual vaccination data then feeds back into the NIMs from the vaccine providers. Data from the NIMs is also automatically uploaded into GP systems to update the individual's electronic health record with their vaccination history.

Hospitalisations – SARI-Watch

The Severe Acute Respiratory Infection (SARI) Watch surveillance system was established in 2020 to report the number of laboratory confirmed influenza and COVID-19 cases admitted to hospital and critical care units (ICU/HDU) in NHS acute trusts across England. SARI-watch replaced the COVID-19 Hospitalisation in England Surveillance System (CHESS) which was initiated across all NHS Trusts in England on 15 March 2020. SARI-Watch replaced CHESS in summer 2020 and collects the same data items as CHESS but includes infections other than COVID-19.

The weekly rate of new admissions of COVID-19 cases is based on the trust catchment population of those NHS Trusts who made a new return. This may differ from other published figures such as the total number of people currently in hospital with COVID-19.

Hospitalisations - Emergency Care Data Set (ECDS)

PCR positive cases detected in pillar 2 testing are linked to the Emergency Care Data Set (ECDS) (4) to determine the proportion of the cases admitted to hospital. The ECDS is a national data set managed by NHS Digital and established to provide a more accurate, detailed and complete picture of all emergency attendances. Linking is undertaken on the basis of NHS number and date of birth.

Deaths

Mortality in PCR positive cases is determined by linking on a daily basis to the Demographic Batch Service (DBS) to check NHS patient records for reports of individuals who died in the previous 24 hours.

Results

Vaccine effectiveness against symptomatic disease in over 70s

The screening method (5), uses population vaccine coverage data and case vaccination histories to estimate vaccine effectiveness from routine data. Symptomatic cases in individuals who turned 70 years of age before the 31st March 2021 and confirmed PCR positive by pillar 2 testing between 8th of December 2020 and 12th February 2021 were extracted and matched to records in the NIMs system to identify their vaccination status. The total number of confirmed cases with NIMS linkage in those aged over 70 years was 43,294.

The expected vaccine coverage for each case was estimated by identifying a matching set of individuals in the NIMs population based on age, sex, region and living in a care home, and establishing their vaccination status on the day of the case onset. The matching coverage is then compared with the observed cases grouped using daily intervals from the first and second dose and by type of vaccine. To estimate the odds ratio in any defined interval after vaccination the proportion of cases that were vaccinated in that interval, excluding those vaccinated at other intervals1 and with the other vaccine, is compared with the proportion of age, region, care home and sex matched NIMS population using their vaccination status on the same day of onset.

Using the calculated odds ratios, the number of cases expected on each day after vaccination was then estimated assuming the vaccine had no effect, whilst allowing for increasing vaccination coverage and follow up over time. The cumulative observed cases in vaccinated individuals were compared to the number of expected cases on each day after the first dose of Pfizer vaccine in those aged over 70 years, and can be seen diverging from the expected number soon after day 14. (figure 1)

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1 The proportion of the cases (or population) who had received vaccination x days (e.g. 14 days) earlier is estimated excluding those who were vaccinated at other time intervals. For example, if within the cases 5,500 were unvaccinated and 100 vaccinated 14 days earlier the adjusted coverage in the cases is 100/(100+5500) = 1.79%. Similarly if on the matched day of onset, 2% of the population had been vaccinated with Pfizer 14 days previously, 60% remained totally unvaccinated and the remaining 38% were vaccinated at longer or shorter time intervals then adjusted coverage is 3.22% (2/(2+60)). This gives an odds of vaccination in the cases of 0.0179/(1-0.0179)=0.018 and in the population of 0.0322/(1-0.0322) = 0.033. The odds ratio is then 0.018/0.033 = 0.55.

Vaccine effectiveness against symptomatic disease and severe outcome in over 80s

As the first group to receive vaccine, follow up for severe outcomes is most complete in this age group. Few participants in the clinical trials were over 80 years of age, and it is unlikely that frail elderly, such as those in care homes, were excluded.

A total of 12,754 confirmed cases of COVID in those aged over 80 years were available for analysis; after excluding those who had received AstraZeneca vaccine before onset, that left 11,860 cases for analysis. The odds ratios of observed versus expected cases in Pfizer vaccinated individuals aged over 80 years, continues to decrease for up to four weeks after vaccination and then appears to plateau (table 1).

Vaccine effectiveness in over 80 year olds, estimated as 1-odds ratio, was 57% (95% CIs 48-63%) from 28 days after the first dose of vaccination (table 1). Protection after the second dose rises to 88% after 7 days (95% CIs 84-90%), although the group eligible for both doses is not likely to be representative of all over 80s - for example this would not include any care home residents.

Risk of admission within 14 days of sample date in 10,926 individuals aged over 80 years with a confirmed PCR positive test and sufficient follow up time was compared for cases with and without a history of vaccination. There was evidence of a lower rate of admission amongst vaccinated cases, at least 14 days after a single dose (table 2a).

In 8,119 individuals aged over 80 years with a confirmed PCR positive test and followed for at least 21 days, case fatality ratio was lower in cases vaccinated at least 14 days before onset than in unvaccinated cases (table 2b). This indicates that within vaccinated individuals who do become symptomatic cases the vaccine confers additional protection against death.

Impact of vaccination on hospitalisation and mortality

Trends in the weekly rate of hospitalisations recorded in SARI-Watch by age group are shown in figure 2a. Rates are declining in all age groups, although the peak appeared to be earlier in those aged over 75 years of age compared to those aged 65-74 and 45-64 years. The rate of decline is now slightly higher in the oldest age group who have been targeted for vaccination (figure 2a). In contrast, after the first lockdown the oldest age groups were the slowest to decline (figure 2b).

Trends in the weekly rate of hospitalisations by age group are shown in figure 3a. Rates are declining in all age groups, although the rate of decline is now slightly higher in the oldest age groups who have been targeted for vaccination (figure 3a). This compares with the decline in deaths in the first lockdown, where the oldest age groups were the slowest to decline (figure 3b).

Limitations

This data contains a range of potential biases that will potentially reduce the estimates of vaccine effectiveness. For example, those targeted for vaccination early may have been at higher risk of COVID-19 than those vaccinated later, there may be misclassification of cases because of non-specificity in the testing methods, there could be immune individuals in the population who were not able to be excluded because their previous infection was not confirmed, not all of those with confirmed infection were genuinely symptomatic, plus people may behave differently after vaccination and thus increased their risk of exposure. In contrast, some biases will tend to increase the estimated effectiveness. For example, people who have been exposed to COVID or tested positive may defer vaccination.

Conclusions

This first report summarises early routine data on the impact and effectiveness of the COVID-19 vaccination programme in England. Evidence so far relates to the impact of the Pfizer vaccine as AstraZeneca vaccine has only been in widespread use for a few weeks.

Data from the SIREN (Sarscov2 Immunity and REinfection EvaluatioN) study in UK healthcare workers, have recently suggested that protection against infection from a single dose of the Pfizer vaccine was 72% (95% CI 56-82%) (6). This corresponds closely with the data from Israel that suggested 75% protection against all infections (85% against symptomatic infection) after a single dose of Pfizer vaccine in healthcare staff (7).

Protection in young health care workers, who are largely a young and healthy group, may not reflect the levels of protection expected in older people, particularly those aged over 80 years and the frail elderly in care homes. Our evidence suggests a greater than 50% reduction in symptomatic cases, even in older vaccinees, including those in care homes, from around 3 weeks after the first dose of Pfizer vaccine. As this estimate is based on routine observational data, the estimated level of protection is subject to some bias, that cannot be controlled for in this analysis. Most of these biases are likely to lead to an under-estimate of effectiveness and so this figure likely represents a minimum. Additional analyses comparing vaccination status in symptomatic cases to those testing negative and within GP datasets have given slightly higher vaccine effectiveness estimates in older adults after a single dose (ranging from 60-70%) (data not presented).

In addition to the overall reduction in cases, early data suggest that that any cases that do occur in older vaccinated people are around as half as likely to lead to hospitalisation and/or death. This suggests that those that do develop symptomatic COVID-19 infection after vaccination have a less severe outcomes. As follow up time is limited, we only looked at those vaccinated at least 14 days earlier, it is likely that lower rates of hospitalisation and death would be observed in those vaccinated more than 3 or 4 weeks earlier. These observations are consistent with a higher level of protection (probably above 75%) against severe disease from a single dose of Pfizer vaccine in the over 80s. This is supported by early data on protection against hospitalisation from Scotland (8).

In terms of population impact, there is a suggestion of a slightly higher rate of decline amongst hospitalisations and deaths in the older vaccinated age groups. This is in contrast to the age specifc rate of decline after the first lockdown. The faster decline observed during this more recent lockdown may therefore be attributable to the high vaccination coverage achieved in this age group.

Tables and Figures

Table 1: Observed and expected cases in vaccinated people over 80 years of age by interval since Pfizer vaccination

Vaccination status	Cases		Odds ratio	95% confidence interval
	Observed	Expected		
Unvaccinated	8909	8909	1	
Dose 1				
0-3 days	432	621	0.70	0.63-0.77
4- 6 days	406	473	0.86	0.77-0.95
7-9 days	472	463	1.02	0.92-1.12
10-13 days	524	639	0.82	0.75-0.90
14-20 days	564	915	0.62	0.56-0.68
21-27 days	231	440	0.53	0.45-0.61
>= 28 days	185	424	0.43	0.37-0.52
Dose 2				
0-3 days	45	141	0.32	0.24-0.43
4-6 days	30	95	0.32	0.22-0.46
>= 7 days	62	499	0.12	0.10-0.16

Table 2a: Risk of admission to hospital with 14 days of confirmed SARS-CoV2 infection in Pfizer vaccinated and unvaccinated cases aged over 80 years

Vaccination status	Cases	Hospitalisations	
		Number	%
Unvaccinated	8,682	1331	15.3%
Test date less than 14 days after first dose	1,260	187	14.8%
Test date 14 days or more after first dose	984	89	9.0%
Total	10,926	1607	14.7%

Table 2b: Risk of death with 21 days of confirmed SARS-CoV2 infection in Pfizer vaccinated and unvaccinated cases aged over 80 years

Vaccination status	Cases	Deaths	
		Number	%
Unvaccinated	6,860	920	13.4%
Test date less than 14 days after first dose	741	80	10.8%
Test date 14 days or more after first dose	518	30	5.8%
Total	8,119	1030	12.7%

Figure 1: Cumulative observed PCR confirmed cases and expected* cases in the absence of vaccination for age >=70, Pfizer vaccine.

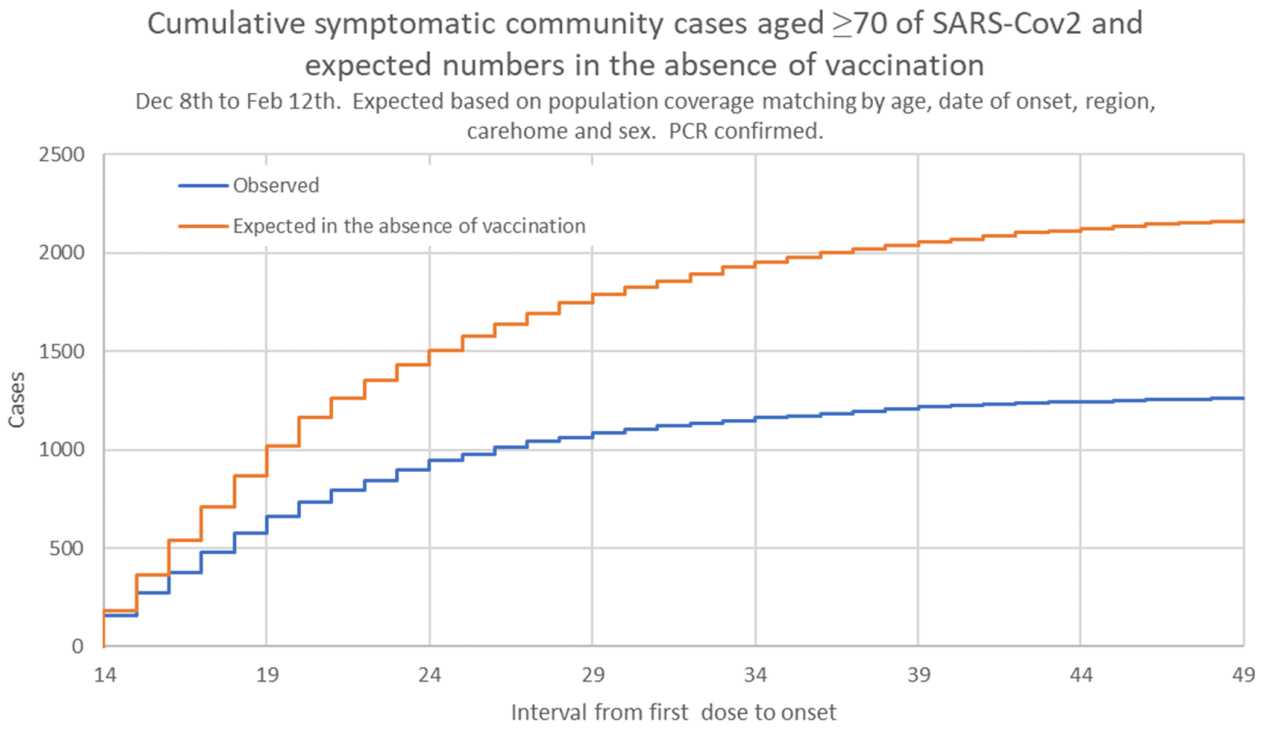


Figure 2a: Trends in weekly rate of hospitalisations for COVID by age group December 2020- February 2021 (source - SARI-Watch)

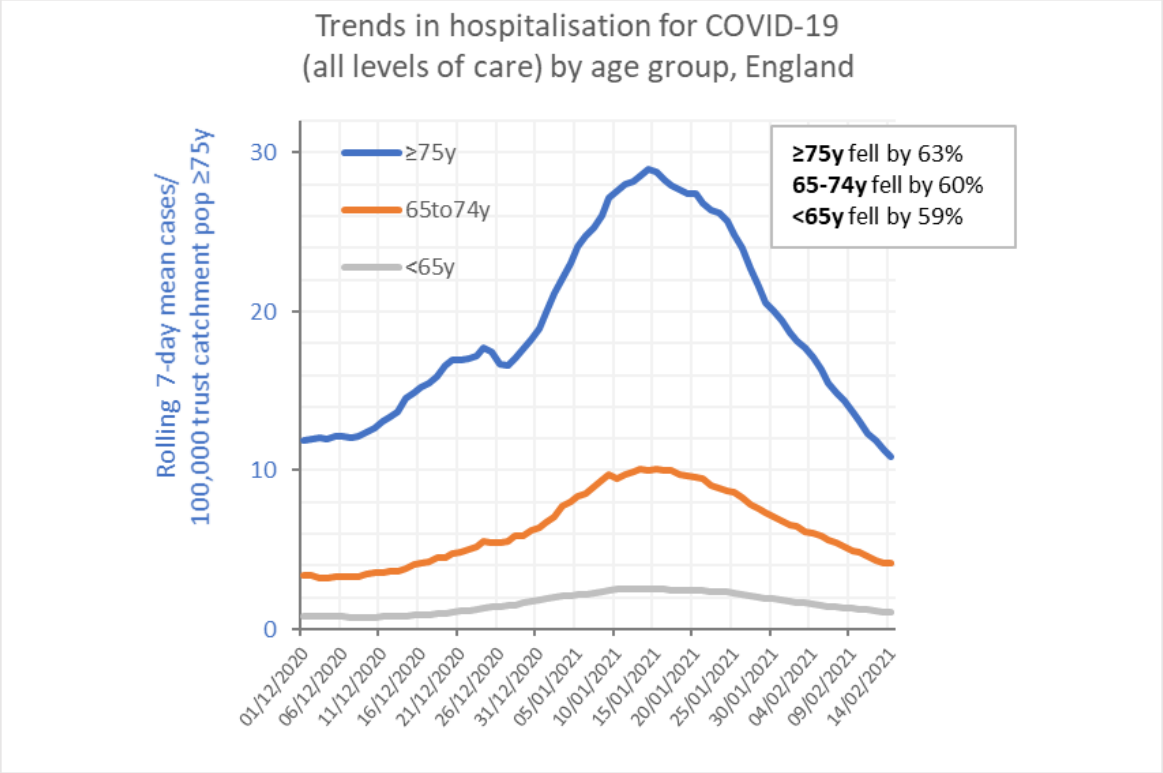
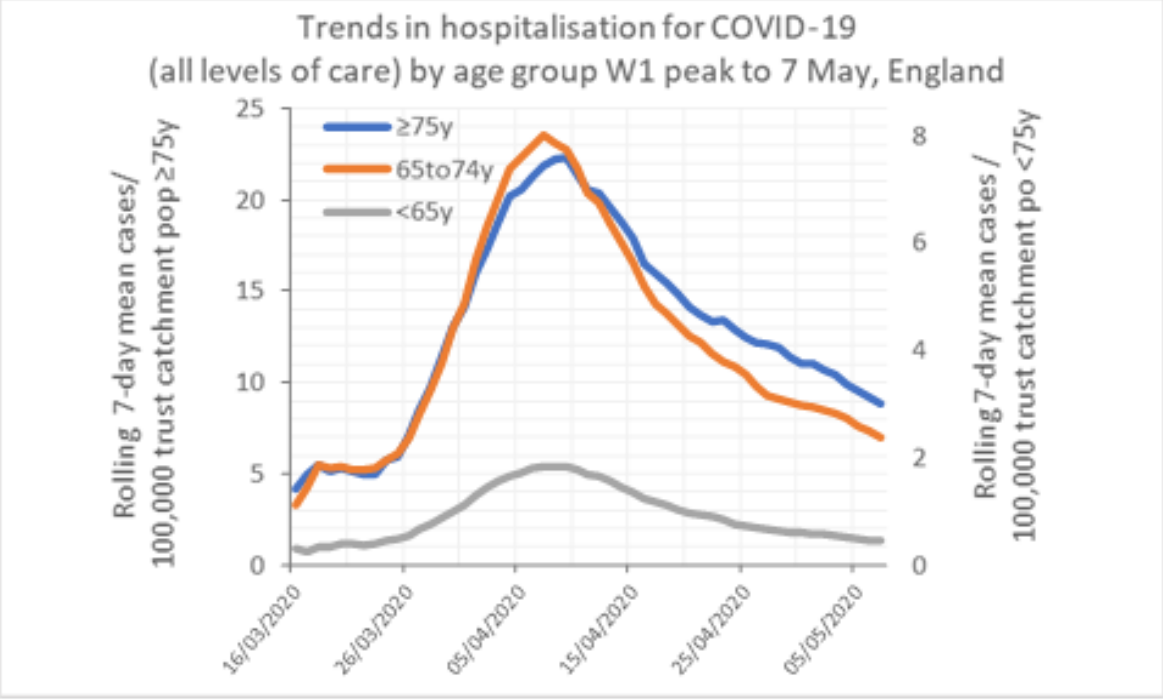


Figure 2b: Trends in weekly rate of hospitalisations for COVID by age group in Wave 1 (March-May 2020) (source – CHESS)



≥75y 7-day mean cases fell by 59%
65-74y 7-day mean cases fell by 69%
<65y 7-day mean cases fell by 74%

Figure 3a: Trends in weekly rate of deaths within 28 days of confirmed SARs-CoV-2 infection by age group (weeks 50 of 2020 to week 6 of 2021)

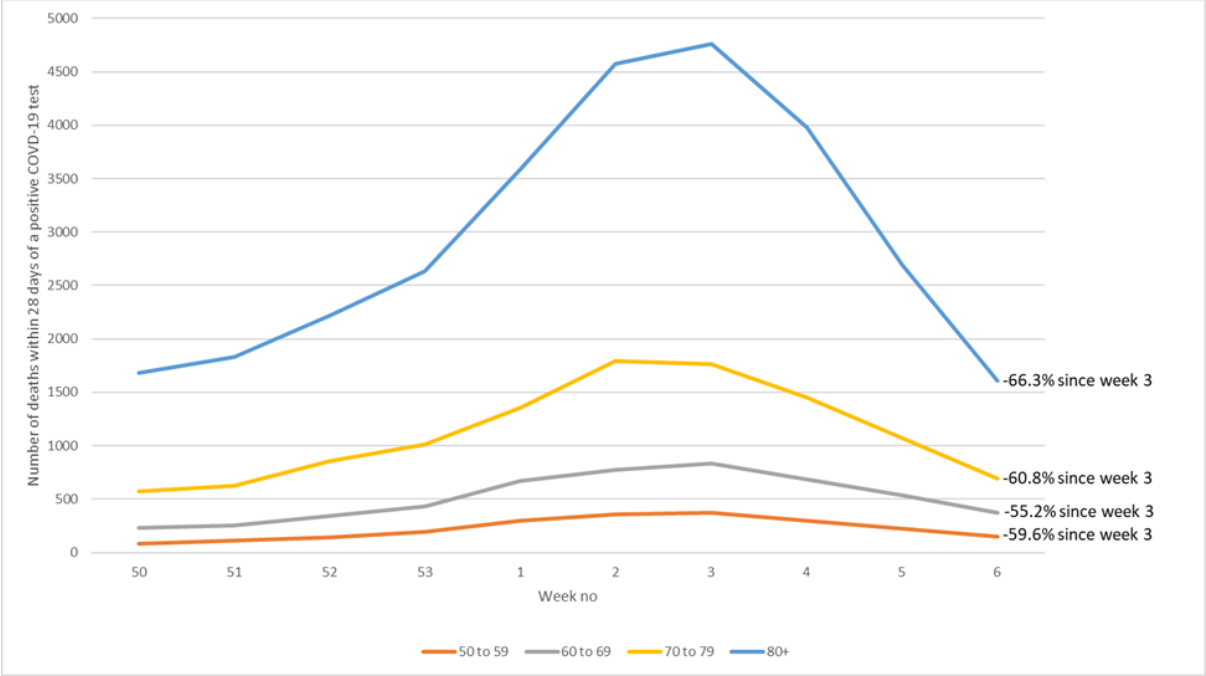
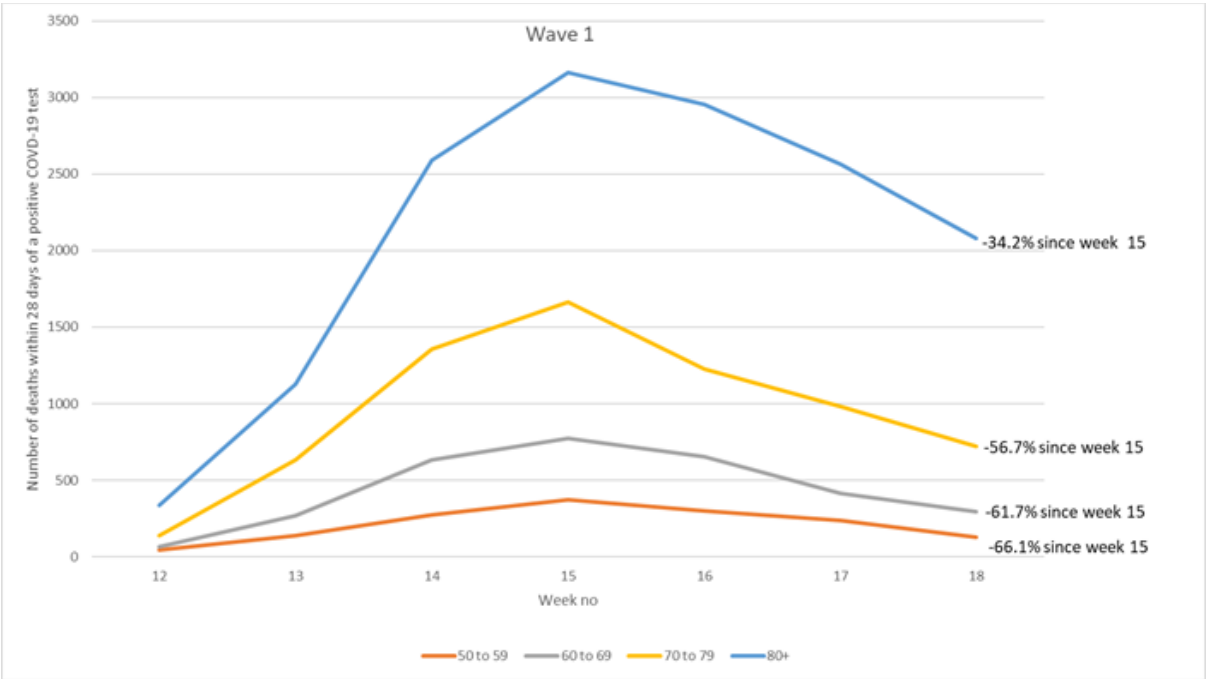


Figure 3b: Trends in weekly rate of deaths within 28 days of confirmed SARs-CoV-2 infection by age group after wave 1 (weeks 12 to 18 of 2020)



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