UK Health Security Agency

Epidemiology Modelling Review Group: consensus statement on COVID-19

Date: 22 December 2021

Introduction

The UK Health Security Agency (UKHSA) Epidemiology Modelling Review Group (EMRG) shares this consensus statement on COVID-19 with acknowledgment to SPI-M-O, who have developed and shared modelling methodologies and contribute model outputs to these combined estimates.

All probability statements are in line with the framework given in Annexe A.

Summary

1. UKHSA's best estimate for R in England is between 1.0 and 1.2. R is estimated to be between 0.9 and 1.1 for Wales, 1.0 and 1.3 for Scotland, and 0.9 and 1.1 for Northern Ireland (Figure 1). These estimates are based on models[1] fit to data available up to 20 December 2021, including hospitalisations, deaths, testing, wastewater samples and longitudinal studies.

2. R lags changes in transmission by 2 to 3 weeks, due to the time required to see changes in data streams. It is an average over time, geographies, viral variants, and communities. These estimates would not be expected to fully reflect the recent rapid growth of Omicron.

3. Combined estimates[2] show that the incidence[3] is between 73,000 and 104,000 new infections per day in England.

Incidence and prevalence

4. During its most recent week (ending 18 December), the ONS COVID-19 Infection Survey estimates[4] that an average of 1,202,300 people had COVID-19 in the community in England (95% credible interval 1,146,800 to 1,263,000). The survey does not include people in care homes, hospitals or prisons. Estimates from across the 4 nations of the UK are:

- England 1,202,300 (95% credible interval 1,146,800 to 1,263,000)
- Scotland 76,200 (95% credible interval 63,100 to 90,500)
- Wales 54,400 (95% credible interval 44,300 to 65,500)
- Northern Ireland 37,800 (95% credible interval 29,100 to 47,700)

[1] Model estimates are required as quantities such as the Reproduction Number (R) are not directly observable. Instead, a variety of independently produced models are used to interpret the data and estimate R. The combination of models able to be included can change between weeks and therefore care should be taken when drawing week-on-week comparisons.
[2] Different nations and regions may use different sets of models for these estimates; hence caution should be applied in drawing direct comparisons. For example, fewer models produce estimates for Wales and Northern Ireland.
[3] The number of new infections per day.
[4] These estimates can be subject to revision as further information is available and modelled.

Growth rate and reproduction number

For small daily changes, the growth rate is approximately the proportion by which the number of infections increases or decreases per day, that is, the speed at which an epidemic is growing or shrinking. However, at very high growth rates, this relationship does not hold.[5]

5. The EMRG's consensus estimates for the growth rates in the 4 nations are (90% credible interval):

- England is between 0% to +3% per day,
- Wales is between -2% to +1% per day,
- Scotland is between 0% to +4% per day, and
- Northern Ireland is between -2% to +2% per day

National estimates of growth rates are summarised in Figure 2.

6. The reproduction number (R) is the average number of secondary infections produced by a single infected individual; it is an average over time, geographies, viral variants, and communities.

7. UKHSA's best estimate for R in England is between 1.0 and 1.2. R is estimated to be between 0.9 and 1.1 for Wales, 1.0 and 1.3 for Scotland, and 0.9 and 1.1 for Northern Ireland. UKHSA's agreed national and regional R estimates are summarised in Table 1, Table 2, Figure 1, and Figure 3.

8. R is an indicator that lags changes in transmission by 2 to 3 weeks[6], due to the time required for changes to be seen in data streams. Therefore, while epidemic estimates for R and other metrics such as growth rate, use the latest data available up to 20 December 2021[7], the estimates reported here represent the epidemic situation as at 7 December 2021.

9. Estimates of R and growth rate would not be expected to fully reflect the recent rapid growth of Omicron VOC-21NOV-01 (B.1.1.529), due to the time required to see changes in the datastreams, and averaging across the epidemic.

10. As Omicron increases, its growth will increasingly be represented in the consensus estimates. This week in London we note an increase in R (1.2-1.6) and growth rate (+3 to +8), the English region where Omicron increased quickly first.

[5] Further Technical Information on the growth rate can be found in Plus Magazine: The growth rate of COVID-19 | plus.maths.org.
[6] Different data-streams and different models are expected to be lagged in their estimates by different amounts when compared with the true underlying epidemiological situation. This is due to multiple lags such as reporting and delays in the infection processes.
[7] Different models fit to different windows of time using different methodologies, hence not all models will fit up to this precise date.

11. Early analysis suggests that the risk of being reinfected (having COVID more than once) is higher with Omicron than other variants[8]. However, in all nations (except Wales) if a person has had more than one positive SARS-CoV-2 test, they are only counted as one case. This means that models using case data may underestimate transmission, particularly in areas where Omicron is growing quickly. This is unlikely to have materially impacted the estimates this week, but will be kept under close review.

12. Estimates of R and the growth rates per day become less useful in determining the state of the epidemic when there is a high degree of immunity to the circulating variant in the population. Particular care should be taken when interpreting these estimates.

13. In addition, changes in population immunity can impact datastreams, with alterations to the relationship between cases and health outcomes, such as hospital admissions. In some settings we currently observe cases to be rising, but hospital admissions are not. The EMRG is monitoring the data patterns, and notes here the increased uncertainty of this context.

14. It is also noted that these relationships could change again, should immune protection to any new variant in circulation differ.

15. R and growth rate estimates indicate the magnitude of growth or decay of the epidemic. However, these indicators should be considered alongside other measures of the epidemic, such as incidence[9], and prevalence[10]. When prevalence is high, as it has been in recent weeks, when R is around or below 1, the absolute number of new cases will be high.

[8] Commentary on this can be found in UKHSA variants technical briefing: SARS-CoV-2 variants of concern and variants under investigation (publishing.service.gov.uk)
[9] The number of individuals who develop the disease within a specified time period
[10] The proportion of the population with the disease at a given point in time

Table 1. Combined estimates of R values growth rates and doubling times in the 4 nations of the UK (90% credible interval)

Nation	R	Daily growth rate	Doubling time[11]
England	1.0 to 1.2	0% to +3%	26 days to flat
Wales	0.9 to 1.1	-2% to +1%	-36 days to flat
Scotland	1.0 to 1.3	0% to +4%	20 days to flat
Northern Ireland	0.9 to 1.1	-2% to +2%	Flat

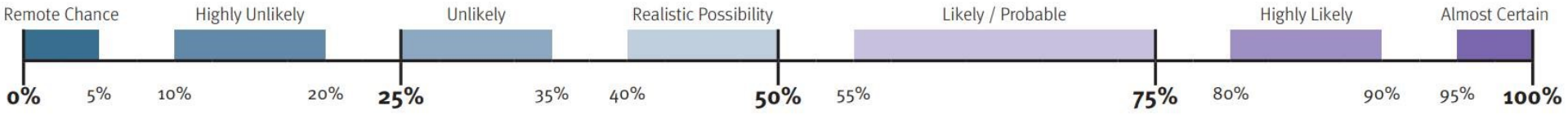
Table 2. Combined estimates of R values growth rates and doubling times in the NHS England regions (90% credible interval)

NHS England region	R	Daily growth rate	Doubling time[11]
England	1.0 to 1.2	0% to +3%	26 days to flat
London	1.2 to 1.6	+3% to +8%	8 to 22 days
East of England	1.0 to 1.2	0% to +4%	19 days to flat
Midlands	1.0 to 1.1	-1% to +2%	Flat
North East & Yorkshire	0.9 to 1.1	-2% to +2%	Flat
North West	1.0 to 1.2	0% to +4%	22 days to flat
South East	0.9 to 1.1	-2% to +2%	Flat
South West	0.9 to 1.1	-1% to +1%	Flat

[11] Any estimates with a halving or doubling time of more than 40 days have been described as flat. Negative values of doubling time indicate a halving time (the time expected for cases to fall by 50%). Doubling time here is calculated using the growth rate.

Annexe A. PHIA framework of language for discussing probabilities

The yardstick splits the probability scale into 7 ranges from remote chance (0 to 5% probability) to almost certain (95% to 100% probability).



Acknowledgements

UKHSA takes responsibility for this consensus statement and its contents. However, UKHSA would like to acknowledge the work of SPI-M-O and academic partners in developing methodologies and sharing these, as well as continuing to contribute model outputs to the combined estimates. These estimates include contribution from LSHTM (1, 2), Imperial College London (3, 8), University of Warwick (4, 5), University of Exeter and University of Bristol (6), Lancaster University (7), University of Manchester and University of Cambridge (9). UKHSA would also like to thank the European Bioinformatics Institute (10), University of Oxford (11, 12), University of Liverpool (13), and the Institute of Disease Modeling (14) for contributing model outputs. UKHSA also acknowledges the work developing combination estimates from Defence and Science Technology Laboratory (15). UKHSA also thanks and acknowledges the support and collaboration of the SPI-M-O Secretariat and co-Chairs, as well as colleagues across the 4 nations.

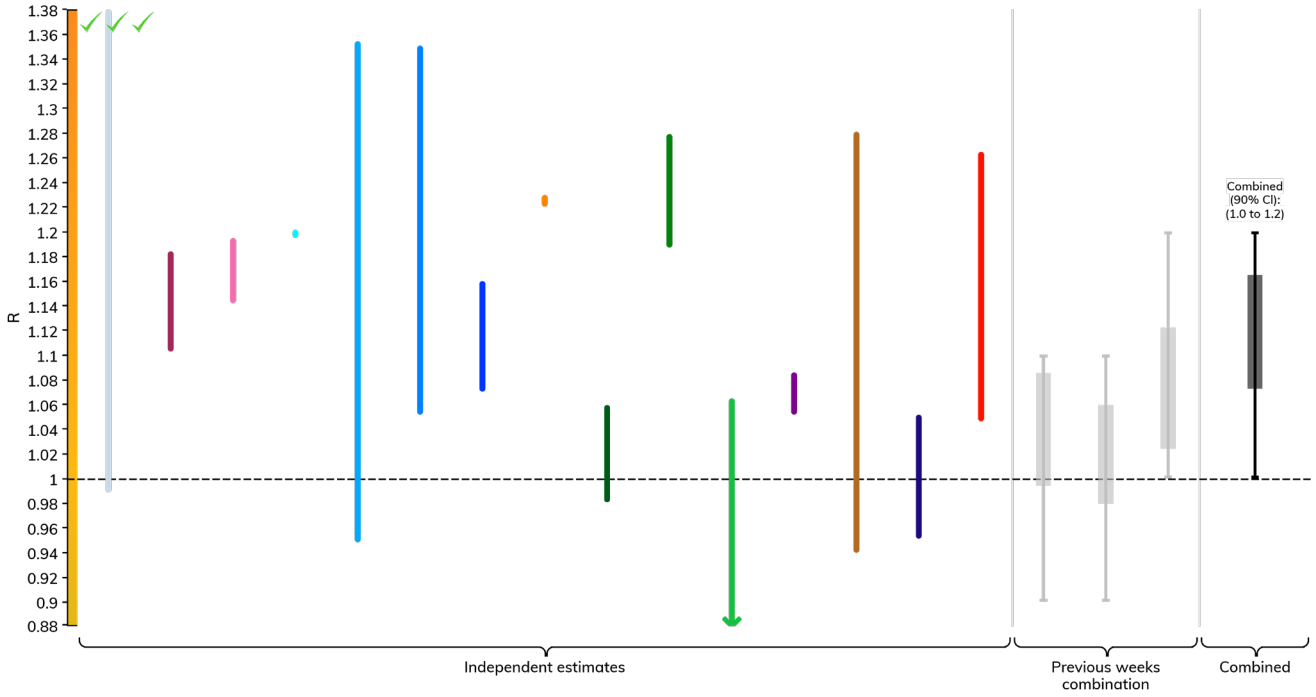
References

1. Abbott, Hellewell and others 'Estimating the time-varying reproduction number of SARS-CoV-2 using national and subnational case counts'. Wellcome Open Research, 8 December 2020
2. Sherratt and others. 'National and Subnational estimates for the United Kingdom'
3. Knock and others. 'Key epidemiological drivers and impact of interventions in the 2020 SARS-CoV-2 epidemic in England'. Science Translational Medicine, 14 July 2021
4. Keeling and others. 'Predictions of COVID-19 dynamics in the UK: Short-term forecasting and analysis of potential exit strategies. PLOS Computational Biology, 22 January 2021
5. Keeling and others. 'Fitting to the UK Covid-19 outbreak, short-term forecasts and estimating the reproductive number.' MedRxiv: 29 September 2020
6. Challen and others. 'Estimates of regional infectivity of COVID-19 in the United Kingdom following imposition of social distancing measures.' Philosophical Transactions of the Royal Society B: 31 May 2021
7. Jewell and others. 'Bayesian stochastic model-based forecasting for spatial COVID-19 risk in England Technical Concept Note.' Github: 22 September 2020
8. Cori and others. 'A New Framework and Software to Estimate Time-Varying Reproduction Numbers During Epidemics.' American Journal of Epidemiology: 1 November 2013
9. Birrell and others. 'Real-time Nowcasting and Forecasting of COVID-19 Dynamics in England: the first wave?' Philosophical Transactions of the Royal Society B: Biological Sciences, 31 May 2021
10. Vöhringer and others .Genomic reconstruction of the SARS-CoV-2 epidemic across England from September 2020 to May 2021. MedRxiv, 26 May 2021
11. Teh and others. 'Efficient Bayesian Inference of Instantaneous Reproduction Numbers at Fine Spatial Scales, with an Application to Mapping and Nowcasting the Covid-19 Epidemic in British Local Authorities.' LocalCovid.info: 19 April 2021
12. Panovska-Griffiths and others. Modelling the impact of reopening schools in early 2021 in the presence of the new SARS-CoV-2 variant amd with the roll out of vaccination against COVID-19. MedRxiv: 9 February 2021
13. Moore and Phillips. 'Liverpool Covid Model: Model Overview.' Github: 10 March 2021
14. Kerr and others. 'Covasim: an agent-based model of COVID-19 dynamics and interventions.' MedRxiv: 1 April 2021
15. Maishman and others. 'Statistical methods used to combine the effective reproduction number, R(t), and other related measures of COVID-19 in the UK.' arXiv preprint, 3 March 2021

Figure 1a. Estimates of R in the 4 UK nations (90% credible intervals) as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to one decimal place.

England



Wales

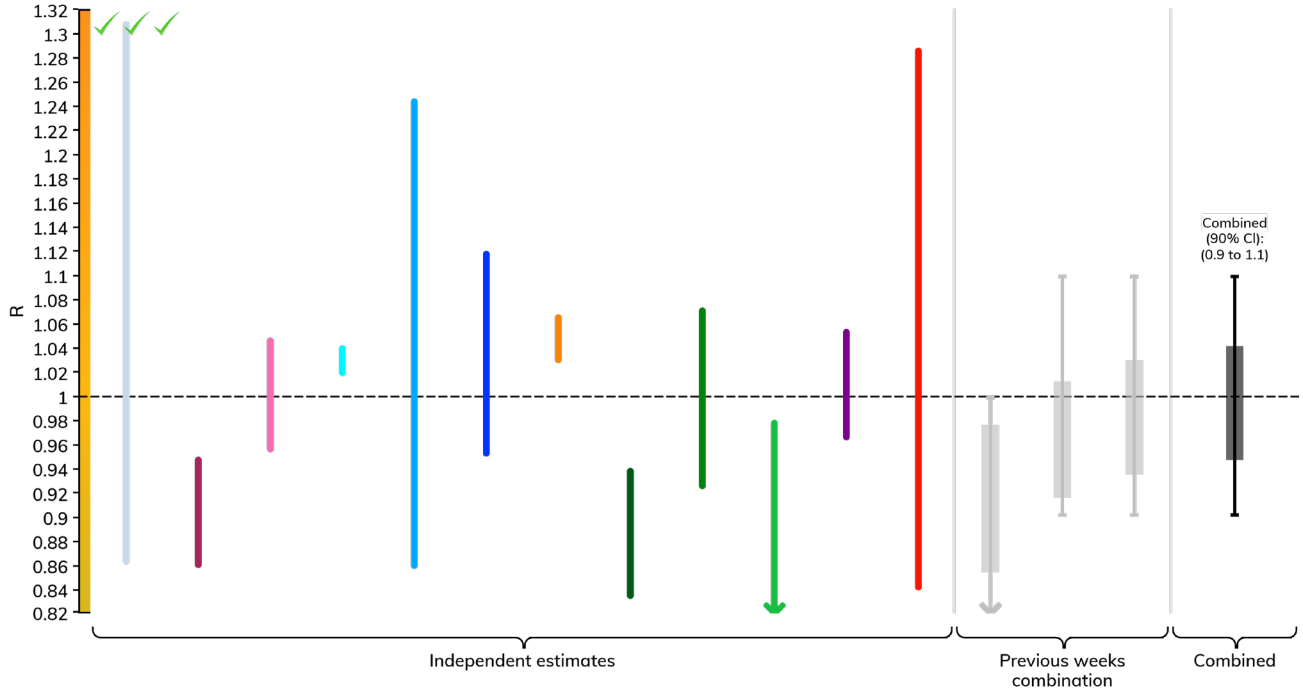
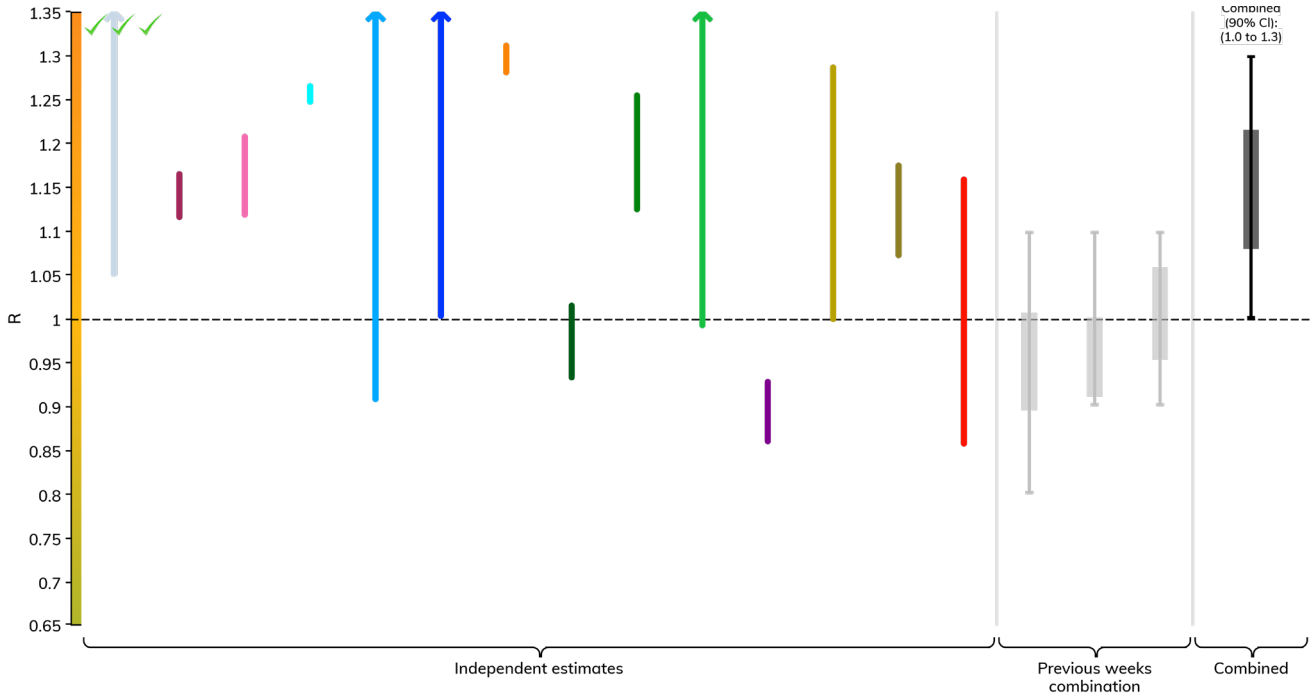


Figure 1b. Estimates of R in the 4 UK nations (90% credible intervals) as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to one decimal place.

Scotland



Northern Ireland

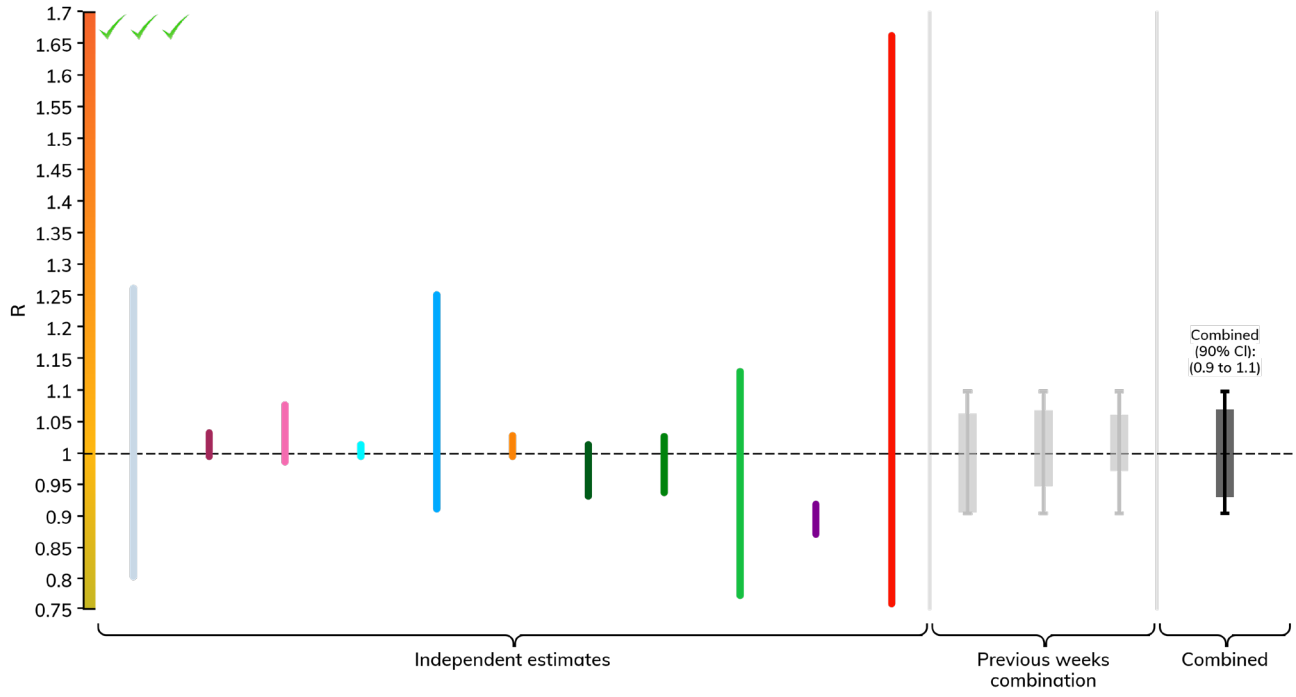
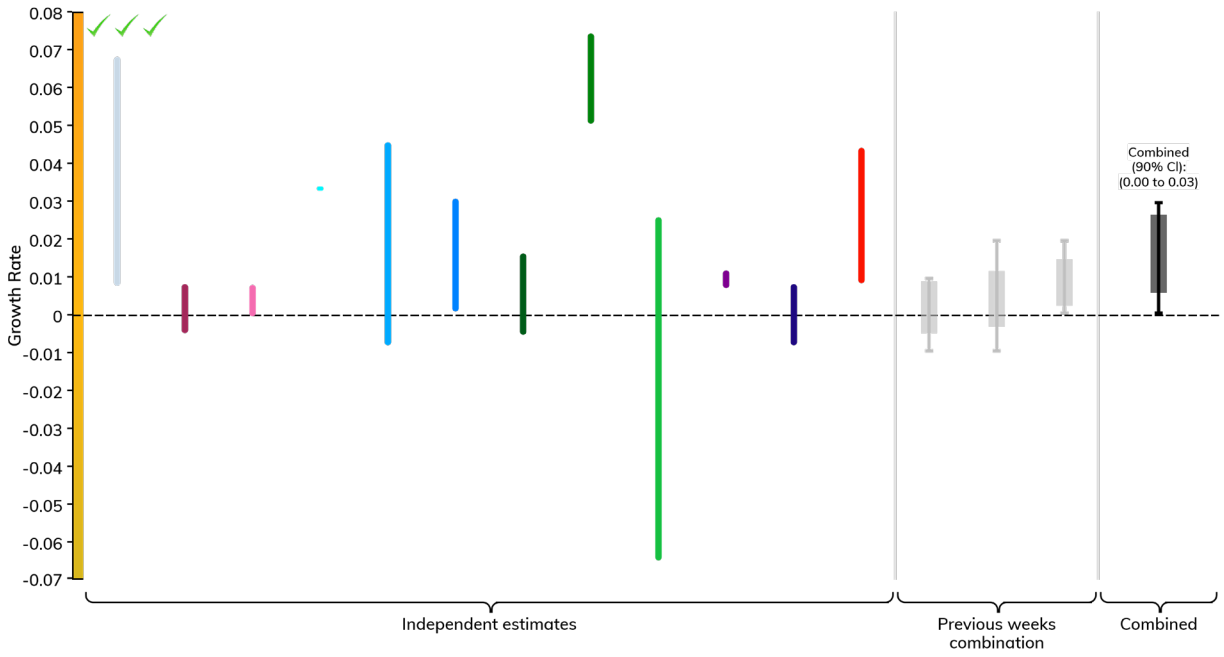


Figure 2a. Estimates of the growth rate in the 4 UK nations, including 90% credible intervals as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to the nearest per cent.

England



Wales

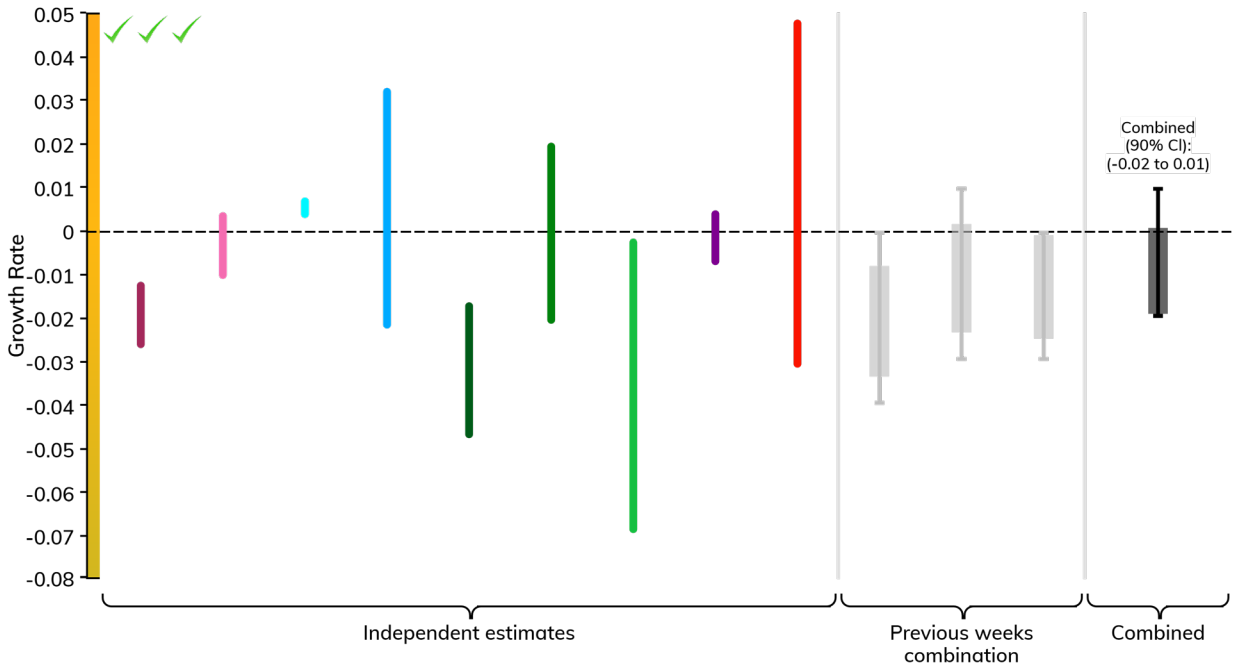
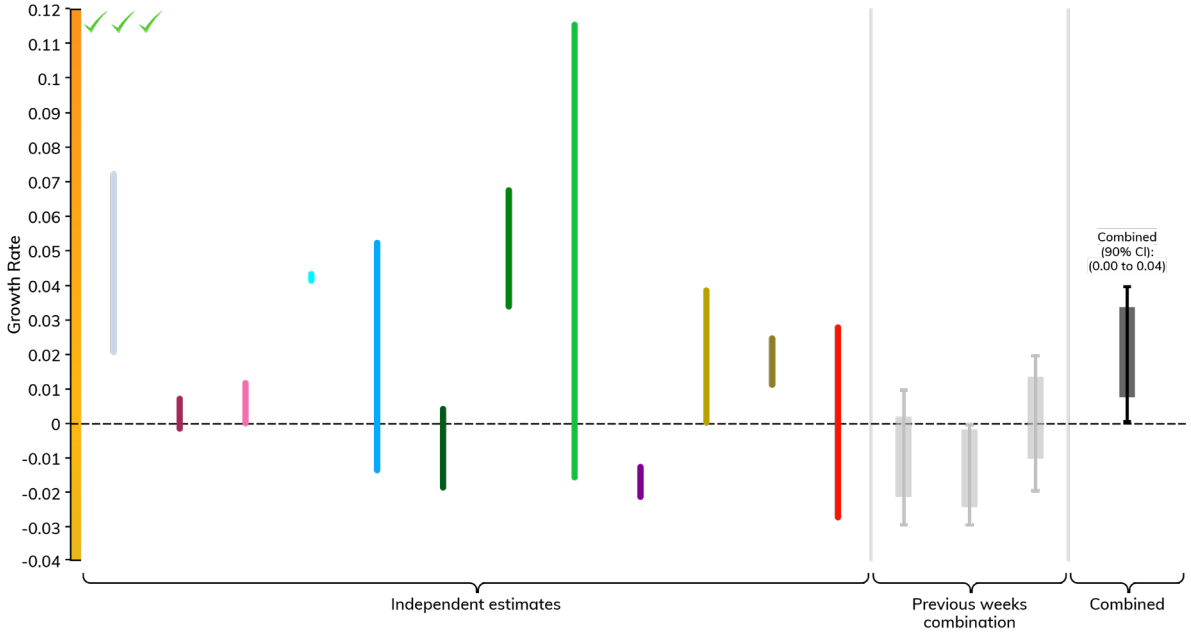


Figure 2b. Estimates of the growth rate in the 4 UK nations, including 90% credible intervals as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to the nearest per cent.

Scotland



Northern Ireland

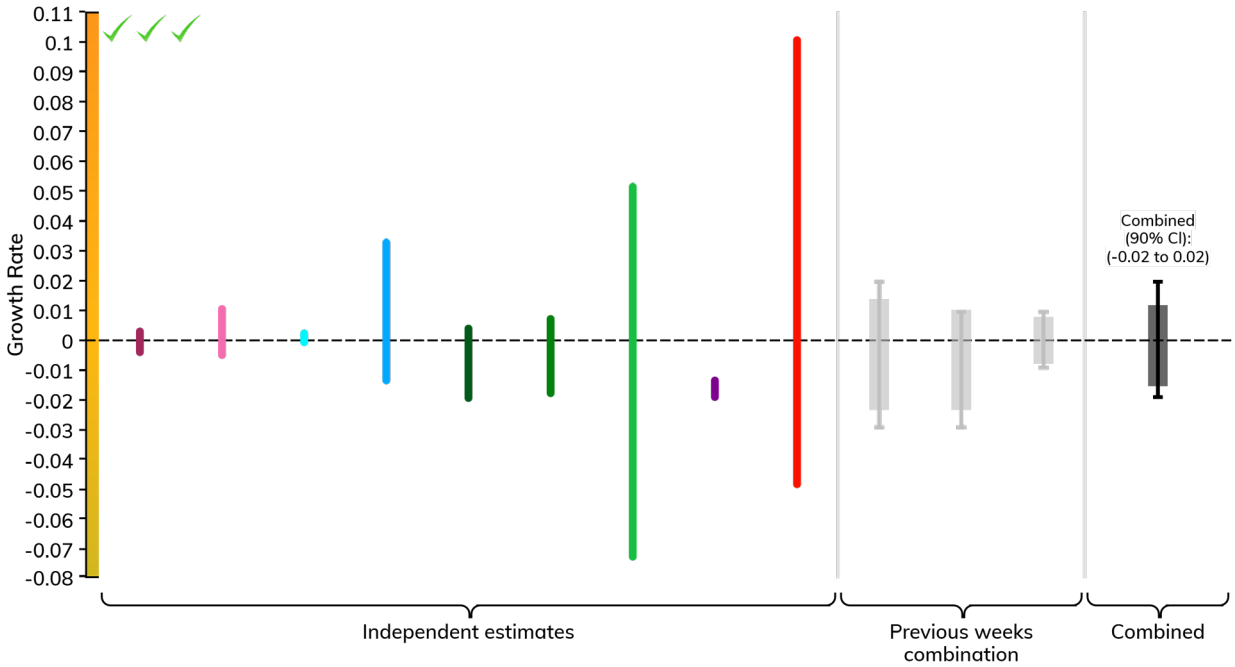
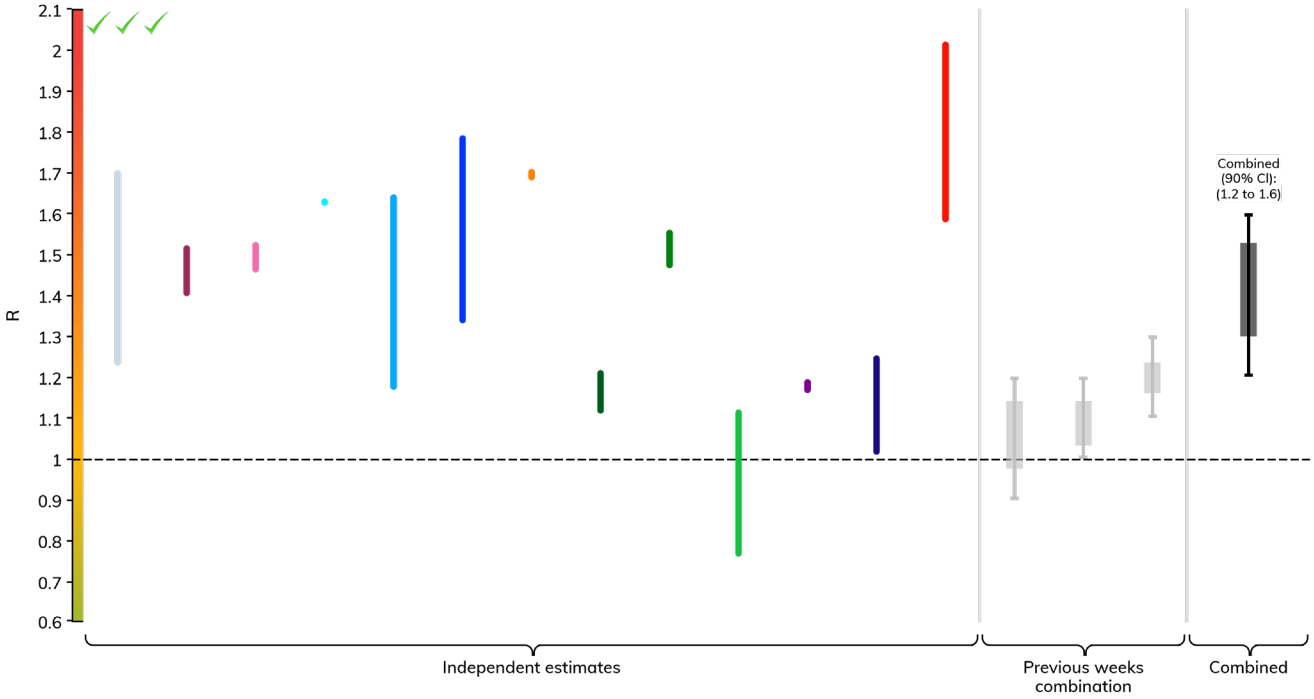


Figure 3a. Estimates of R in the NHS England regions, including 90% credible intervals as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to one decimal place.

London



East of England

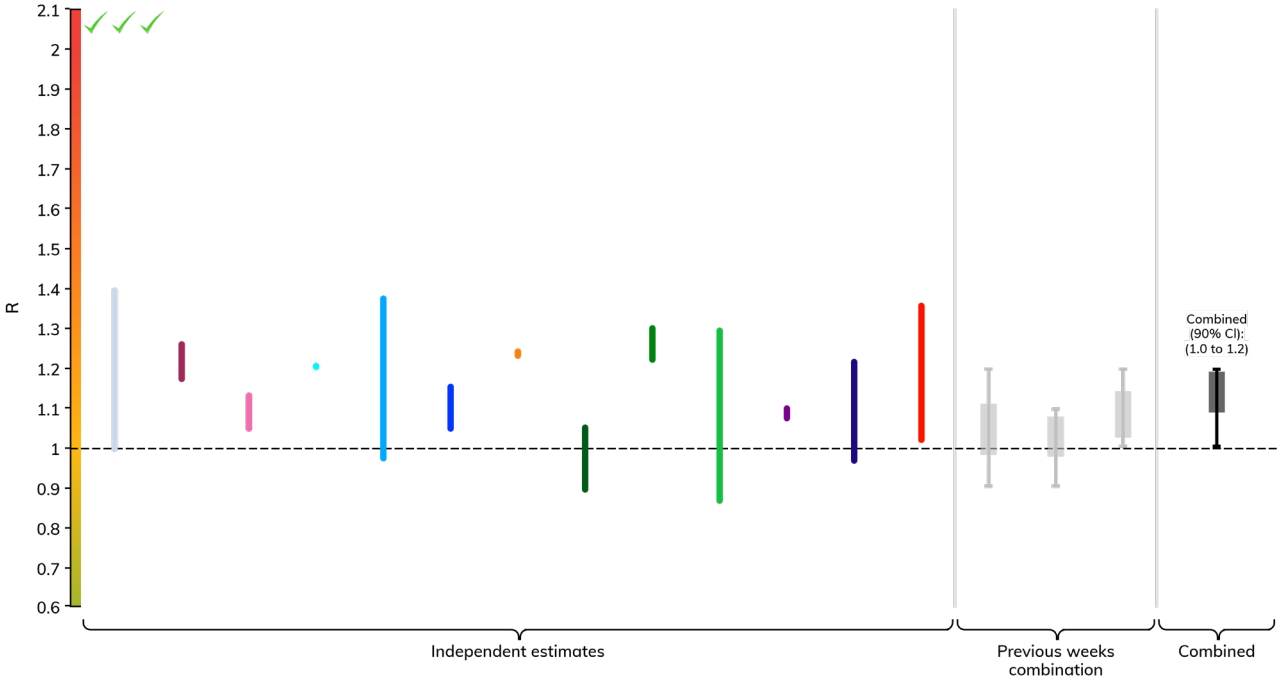
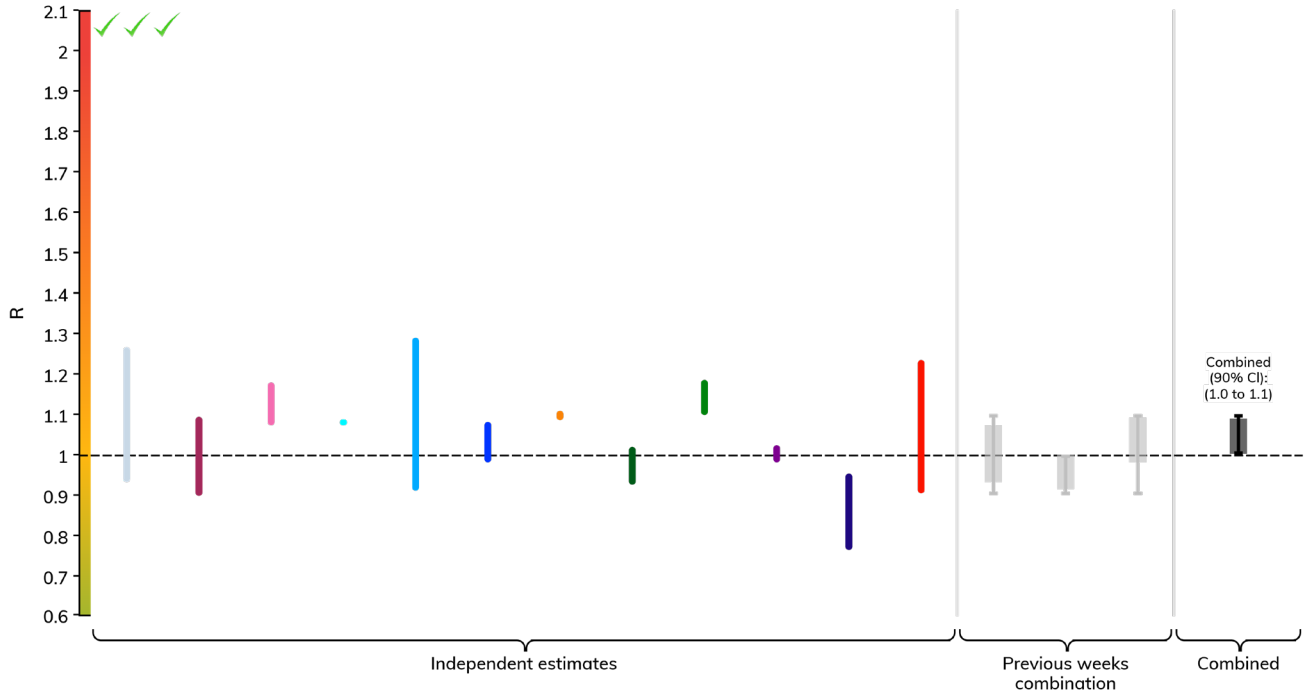


Figure 3b. Estimates of R in the NHS England regions, including 90% credible intervals as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to one decimal place.

Midlands



North East and Yorkshire

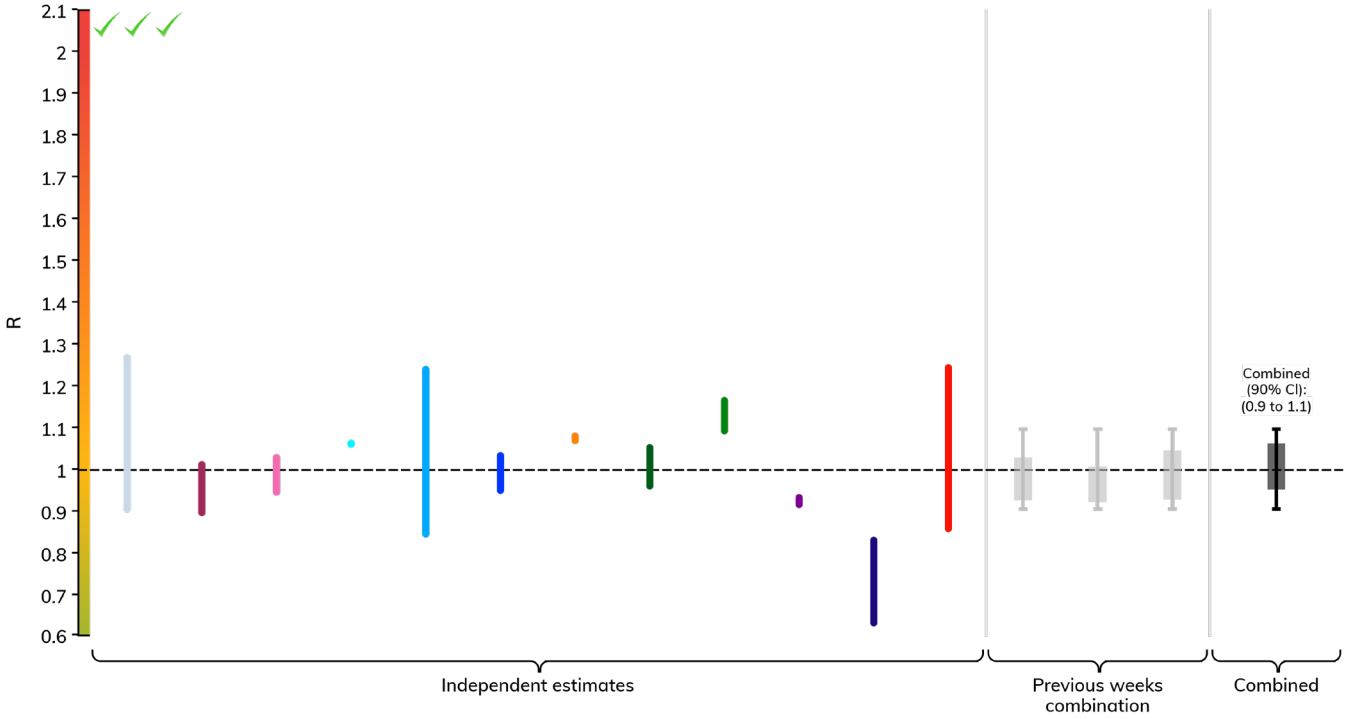
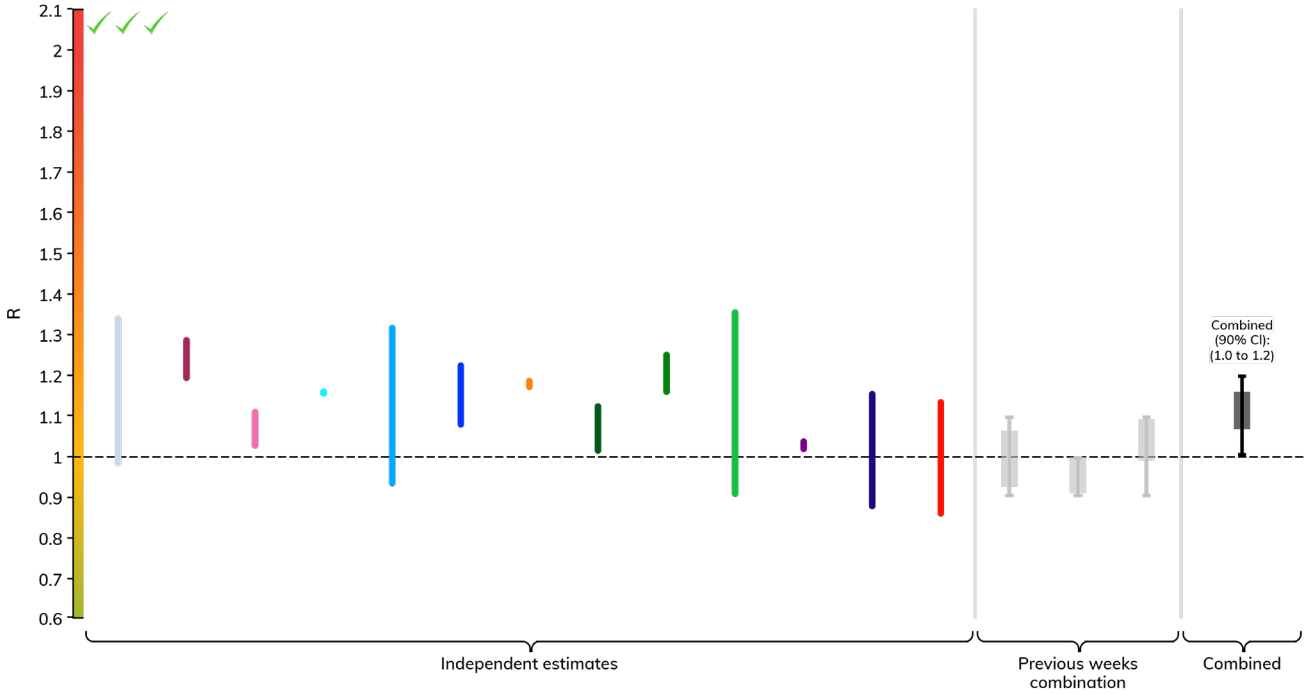


Figure 3c. Estimates of R in the NHS England regions, including 90% credible intervals as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to one decimal place.

North West



South East

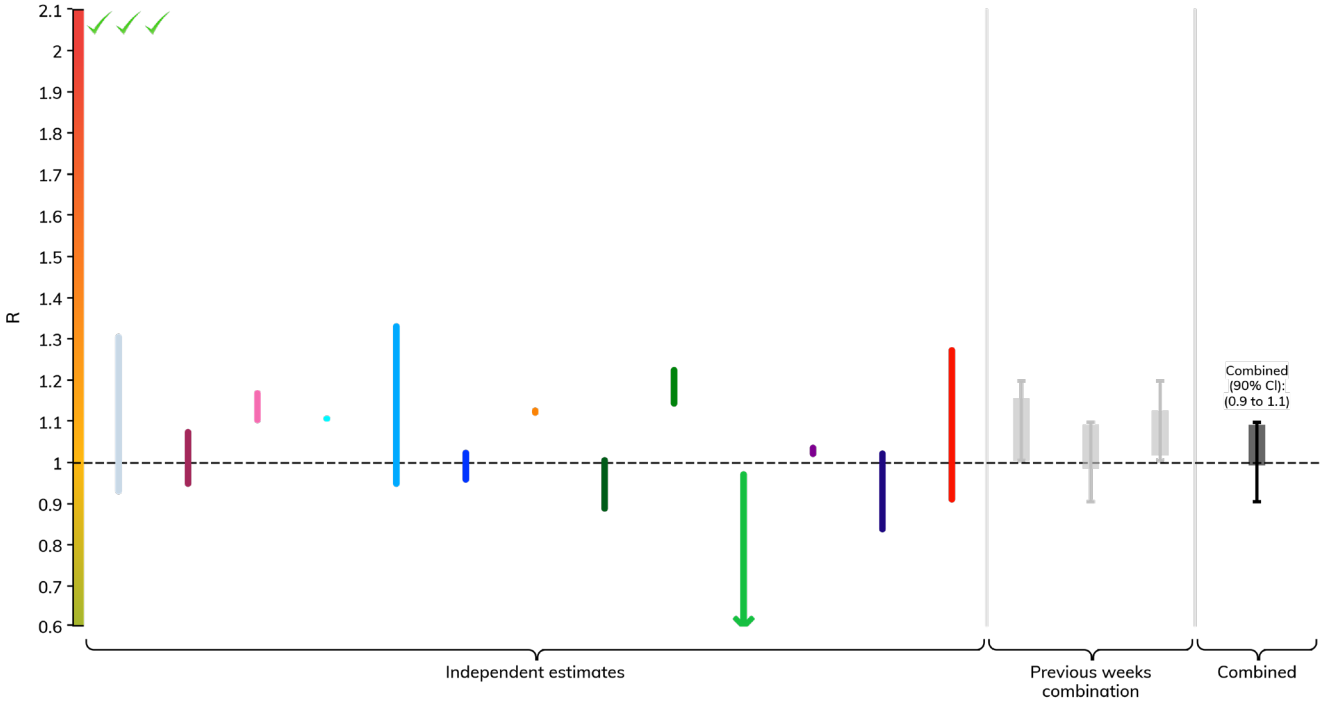
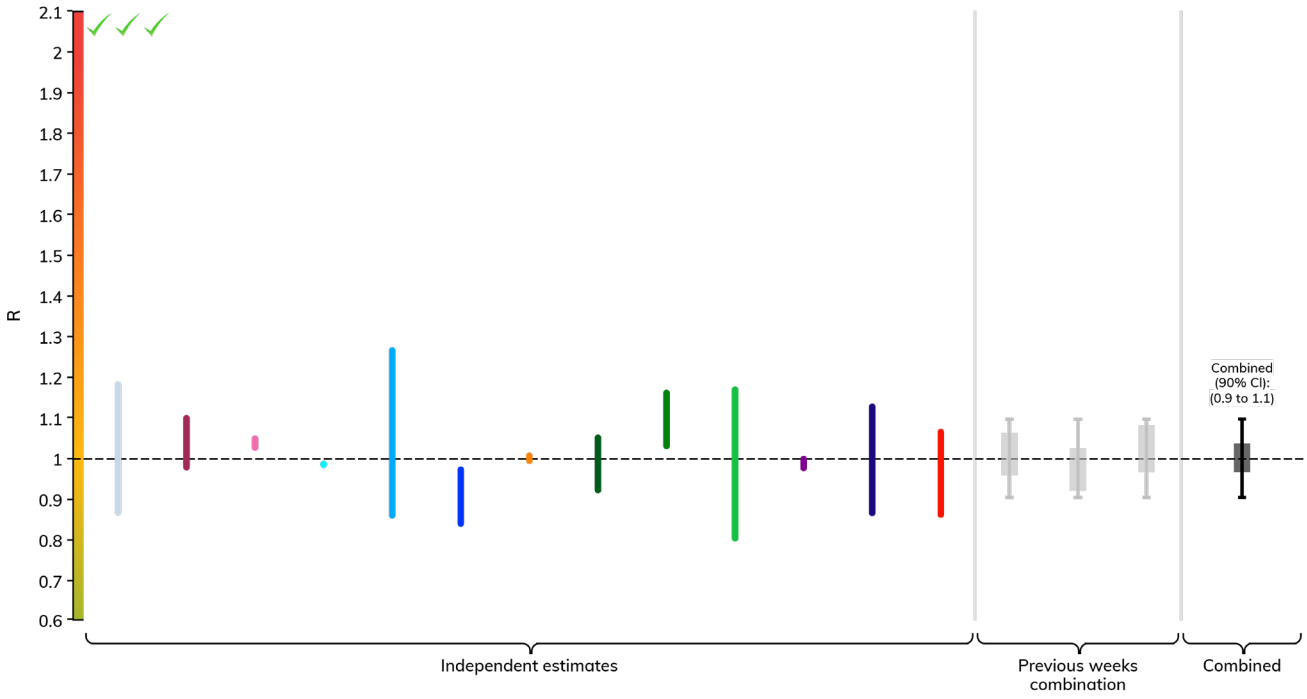


Figure 3d. Estimates of R in the NHS England regions, including 90% credible intervals as at 7 December 2021

Bars represent different independent estimates. The grey shaded areas represent the combined numerical range and the black bars are the combined range after rounding outwards to one decimal place.

South West



About the UK Health Security Agency

The UK Health Security Agency is an executive agency, sponsored by the Department of Health and Social Care.

Published: January 2022
Gateway number: GOV-10986