**LFD mass testing in English schools: evidence of test specificity**

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Background:

The UK government started widespread LFD testing in education settings on 27 November 2020 for higher education, 4 January 2021 in all secondary schools and colleges, and 18 January 2021 in all primary schools, school-based nurseries and maintained nursery schools [1]. Since 5 November 2020, more than 5 million LFD tests have been administered in education settings. There are, however, concerns that large scale use of LFDs may lead to an overwhelming amount of false positive test results, with detrimental consequences due to loss of face-to-face teaching amongst isolating students, and loss of working time amongst working parents.

Methods:

We used the weekly and nationally aggregated number of LFD tests (excluding unknown/void results) and positive LFD tests stratified by educational setting as reported by the NHS [1]. These tests were taken as part of the routine surveillance in educational settings among asymptomatic staff and pupils. From January 2021 schools were closed to all but the children of key workers while nurseries stayed open. In the majority of cases the tests were self administered combined oral-nasal swabs and the LFD test used was the Innova lateral flow antigen test.

We investigate the trajectory of test-positivity as measured by LFD in educational settings and compare it to the trajectory of test-positive cases from routine surveillance.

We further calculate a lower bound for the specificity of the LFD when used in educational settings in England by assuming that at worst all positive tests would be false positive in each of the different assessment periods. If in sample *i* (one week in a type of educational setting as given in the data set) $x_i$ test results are positive among $n_i$ tested, the probability of test specificity *s* being at most *s'*, with *p' = 1 - s'*, is given by

$$P(p > p' | x_i,\ n_i) = \int_{p'}^{1} Beta(p'',\ x_i + 1, n_i - x_i + 1)\ dp''$$

The probability of the test specificity being at most *s'* given all samples *i* is

$$P(p > p' | \{x_i,\ n_i\}) = \prod_i \int_{p'}^{1} Beta(p'',\ x_i + 1, n_i - x_i + 1)\ dp''$$

And therefore the probability of the test specificity being greater than *s'* given all observations is

$$P(s \geq s' | \{x_i,\ n_i\}) = 1 - \prod_i \int_{p'}^{1} Beta(p'',\ x_i + 1, n_i - x_i + 1)\ dp''$$

Results:

LFD test-positivity in education settings followed the general epidemic, indicating that a substantial proportion of LFD positives were true positives (Figure 1 and 2). Since the start of the latest lockdown on 5 January, primary schools and nurseries have had higher test-positivity than secondary schools and colleges, but lower test-positivity than higher education institutions. They were also the only one to increase in the last week of data available (week starting 11 February).

We estimate that with 95% probability the specificity of the LFD testing in educational settings was greater than 99.92%, which is substantially higher than a previously reported point estimate of 99.68% [2]. Our estimate implies that if the true prevalence is as low as 0.1% (0.5%) then more than 45% (80%) of test positives with LFD would be truly infected (assuming a LFD sensitivity of 80%, which is a conservative estimate for detecting infectiousness). Given this estimate we would expect a maximum 4819 (95% CI: 4684-4956) false positive tests among the over 6 million tests administered (including staff) until mid-February, implying at least 7436 (7299-7571) true infections. In the week beginning 4 February, corresponding to the week with the lowest reported infection prevalence in the study period, no more than 1120 (1055-1186) false positives would have been expected in our conservative estimate of specificity implying at least 909 (843-974) true infections recorded. Whilst implying a positive predictive value of less than 50%, this includes the week with the lowest prevalence estimate (amongst staff in secondary schools), where our conservative estimate relies on the somewhat extreme assumption that all positives were false positives.

Conclusions:
LFD tests have even higher specificity than previously reported. Combined with their high sensitivity for detecting infectious infections [3] they can therefore play an important part of pandemic mitigation strategies in educational settings. Nevertheless, as prevalence declines an increasingly large proportion of false positives among the test positives will decrease the utility of mass testing compared to its cost. Disaggregated data by school could further improve the precision of our estimates.

Given that nurseries have been open throughout the current restrictions implemented on 5 January, the flattening of prevalence in nurseries and primary schools at a higher level than that found in secondary schools, combined with a hint of a recent uptick, warrants further monitoring.

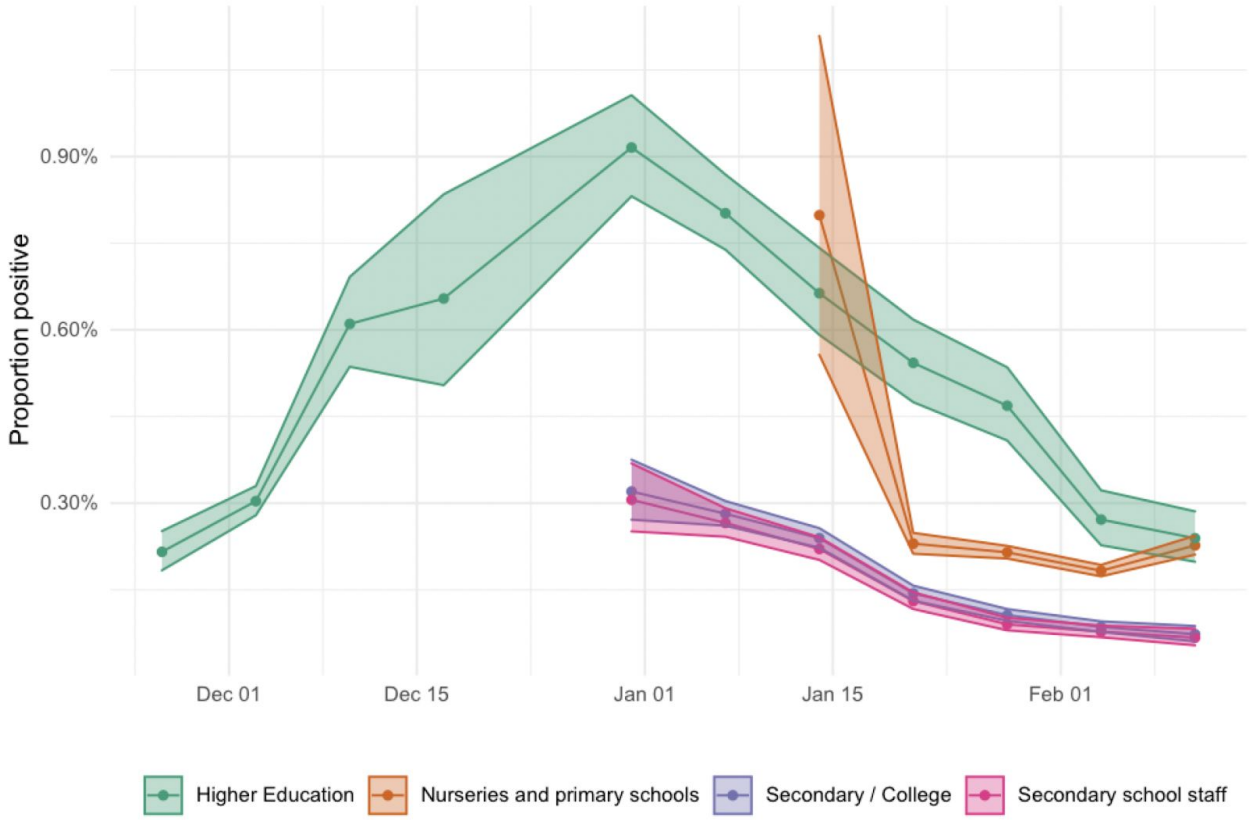


*Figure 1: LFD test positivity as proportion of all LFD tests conducted in different settings (mean: points and lines, 95% exact binomial confidence intervals: shaded area).*

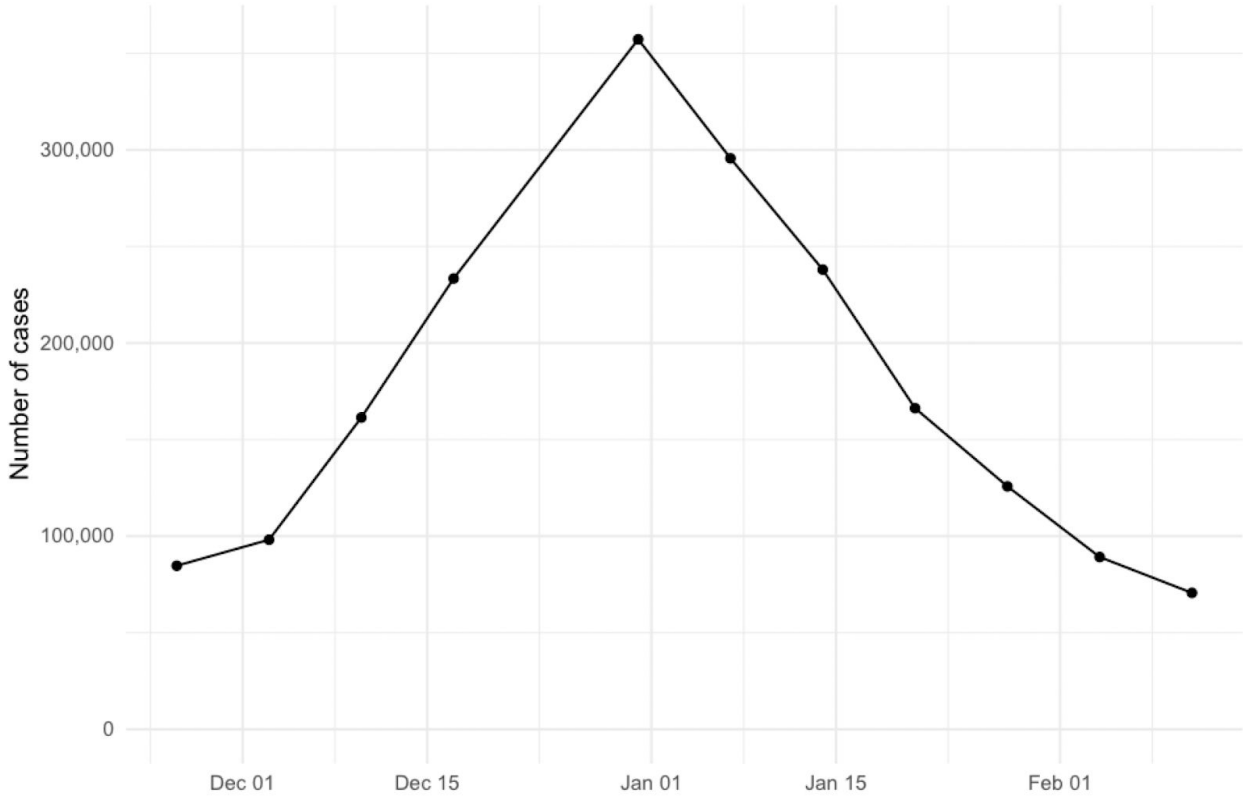


*Figure 2: Total number of test-positive cases in England by date of specimen reported via the Covid-19 surveillance system (https://coronavirus.data.gov.uk/).*

References:

[1] https://www.gov.uk/government/publications/nhs-test-and-trace-england-statistics-11-february-to-17-february-2021

[2] Preliminary report from the Joint PHE Porton Down & University of Oxford SARS-CoV-2 test development and validation cell: rapid evaluation of lateral flow viral antigen detection devices (LFDs) for mass community testing. 8 Nov 2020. https://www.ox.ac.uk/sites/files/oxford/media_wysiwyg/UK%20evaluation_PHE%20Porton%20Down%20%20University%20of%20Oxford_final.pdf.

[3] Comparative performance of SARS-CoV-2 lateral flow antigen tests demonstrates their utility for high sensitivity detection of infectious virus in clinical specimens
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