Public Health Scotland

Report of record linkage study of COVID-19 among teachers, healthcare workers and other working-age adults

Summary report

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Contents

Introduction

On 20 March 2020, nursery, primary and secondary schools closed as part of the Scottish Government's response to the COVID-19 pandemic. All children, except vulnerable children and the children of key workers, stopped attending their usual school for the remainder of the 2019/20 school year. Education was continued via online resources, with the support of parents or carers at home. Schools re-opened to all children for the 2020/21 school year on, or around, 12 August 2020.

As part of a programme of COVID-19 surveillance in education, Public Health Scotland (PHS) has implemented approaches to monitor the impact of COVID-19 on the health of the education workforce. Undertaken with the support of the General Teaching Council for Scotland (GTCS) and Scottish Government Education Analytics, the record linkage approach reported here provides a way of assessing the risk of COVID-19 in teachers, compared with non-teachers. This approach is similar to that taken by PHS to measure the risk of COVID-19 in healthcare workers, and it is therefore also possible to make comparisons with this group.[1]

This report provides the results of this analysis for four periods: before school closure, after school closure and during 'lockdown', after 'lockdown' but before school return, and after school return (up to 26 November 2020). This allows an assessment of risk in two periods when schools were fully open. It is intended that these analyses can be updated through the 2020/21 school year.

Methods

Using record linkage to monitor health

As part of the overall monitoring of the COVID-19 pandemic, PHS gathers information on cases of COVID-19 (individuals who test positive with a PCR-test). Using these data, along with other health records, PHS has been able to estimate the risk of COVID-19 in the Scottish population overall, and according to characteristics such as age, sex and underlying health conditions. However, PHS does not systematically collect data on occupation and so

[1] https://beta.isdscotland.org/find-publications-and-data/population-health/covid-19/hospitalisation-due-to-covid-19-in-healthcare-workers/

cannot estimate the risk of COVID-19 among teachers, or other occupational groups, using only data it holds.

In order to address important health-related questions, such as the risk to teachers from COVID-19, PHS can use an approach called record linkage, which links information from other sources to health data. To undertake the previous analysis on COVID-19 risk in healthcare workers, healthcare records were linked to information from the Scotland-wide NHS human resources database which contains information on the NHS staff.

The General Teaching Council for Scotland (GTCS) maintains a register of all teachers in Scotland who are eligible to be employed as teachers in Scottish state schools and those independent school teachers that have chosen to register ahead of the 2021 deadline. Data held include each teacher's name, date of birth, home postcode, sector (for example nursery, primary, secondary), last known employer and registration number. Teachers are prompted to update their registration details annually. Using these data, it is possible for PHS to identify which cases of COVID-19 in Scotland have occurred among teachers.

With the agreement of the GTCS, PHS obtained approval from the Health and Social Care Public Benefit and Privacy Panel (HS-PBPP) to link its own records to an extract of the GTCS register, to permit estimation of the risk of COVID-19 in teachers. These data were made available on 25 November 2020, and this report shows findings based on that linkage. In addition, the Scottish Government Education Department holds potentially relevant data on current work setting and role for all teachers in Scotland which could also be linked (via the GTCS registration number), and PHS have also applied to the Scottish Government Statistics Public Benefit and Privacy Panel (S-PBPP) to obtain and link these data. Finalisation of this agreement is pending and, if obtained, this information will be included in future reports.

Case-control study

Within PHS, there is a case-control study of COVID-19. This study is described in detail elsewhere and has been used to create a number of internal and external reports, as well as peer-reviewed publications.[2] Briefly, the study includes **all** individuals in Scotland who are ‘cases’ of COVID-19, and for each case ten controls randomly selected from the Scottish

[2] https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003374

population who are of the same age and sex as the case, and are registered at the same general practice, but who do not (at that time) meet the case definition themselves. The case-control study is regularly updated, with the most recent update being performed on 26 November 2020. Both cases and controls are linked to hospitalisation and prescribing data to identify co-existing diseases and to contemporaneous hospitalisation and intensive care data to identify the risk of these outcomes.

As a result of the record linkage described above, we have been able to add information on teacher status to the existing case-control study in order to estimate the risk of COVID-19 in teachers and to compare this to healthcare workers and working-age members of the population who were neither teachers nor healthcare workers (hereafter termed the 'population' comparator). For the purpose of this analysis, only working-aged individuals (those aged 21 to 65 years old) were included.

Outcomes

Outcomes were defined for the case-control study as previously described. Cases were defined as any positive PCR test for SARS-CoV-2, any hospital discharge with a diagnosis of COVID-19 or any death where COVID-19 was included as a cause (regardless of whether it was recorded as the underlying cause). Hospitalisation with COVID-19 was defined in anyone with a positive test for SARS-CoV-2 obtained while they were in hospital, or if they were admitted to hospital 28 days or fewer following a positive test. Severe COVID-19 was also defined as COVID-19 resulting in death or admission to intensive care. All events from the onset of the pandemic until 26 November 2020 were included in the analysis.

Exposure

Within the case-control study, teachers were defined as individuals registered with the GTCS, of working-age and who are currently, or believed to be, working as teachers at a Scottish school at February 2020 or in November 2020. Data were extracted from the GTCS register in November 2020.

GTCS provided information on which individuals were actively teaching in February 2020 solely, in November 2020 solely or during both February and November 2020. Since case-control status is defined at a specific date (generally the date at which a case tested positive

for both cases and their matched control), teachers believed **not** to be actively teaching at this time-point were not defined as teachers for this analysis; within the case-control study, 34 individuals were not actively teaching in February but were in November and 209 teachers were actively teaching in February but not in November.

Teachers were further sub-divided based on their sector. The original categories were collapsed into nursery and primary, primary, secondary and other. The majority of teachers allocated to the 'nursery and primary' category had reported working in a setting with both nursery and primary schools, rather than nursery alone, and most but not all teachers in this group will be teaching primary-aged children in schools with on-site nurseries rather than teaching preschool children within nurseries. The 'other' group comprised further education colleges, local government, 'miscellaneous', 'nursery/primary/special', 'primary/special' and 'special'.

All teachers working in the state sector are included on the register, and from 1 October 2017 all newly appointed teachers working at independent schools have also been required to register. However, the deadline for registration for those already in post prior to 1 October 2017 is not until next year (1 June 2021), so some teachers working in independent schools will not have been included.[3] Fewer than 500 teachers were also removed from the data before it was provided to PHS due to their objecting to the sharing, following notification of the sharing issued by GTCS, or where GTCS were unable to notify individuals of the sharing.

This current work with the GTCS register builds on an earlier analysis based on the publicly available version of the register which contains less information than the data provided to PHS. The results of that interim analysis were shared with the Scottish Education Recovery Group in November and a full report on the methods (which were highly complex) and results of that interim analysis will be published by PHS in time, but the overall findings were broadly consistent with this more definitive analysis.

[3] www.gtcs.org.uk/registration/independent-schools-registration.aspx

Healthcare workers were identified using the General Practitioner Contractor Database (GPCD) and Scottish Workforce Information Standard System (SWISS) databases as previously described.[4]

Outcomes in teachers were compared simultaneously to both healthcare workers (either known to be in patient-facing roles or to have an 'undetermined' status as regards whether or not they were patient facing) and to working-age adults who were neither teachers nor healthcare workers (i.e. members of the general population). Healthcare workers were included in this analysis both for context and as the very high risk of testing positive for SARS-CoV-2 in this group may otherwise have led to a misleading comparator had they been included in the general population. PHS does not hold data on any other occupational groups, hence other relevant groups such as social care workers could not be included.

In order to examine whether the risks differed in relation to the activity within schools we defined several time periods. A priori, a 14-day lag period was provided to allow for the time between exposure to SARS-CoV-2 and development of disease severe enough to require hospitalisation. The following periods were thus defined: before schools closed to most pupils (on or before 4/4/2020), before re-opening while the most severe restrictions were in place throughout Scotland (5/4/2020 to 23/7/2020), when some of these restrictions were lifted but before schools re-opened (24/7/2020 to 2/9/2020) and after schools re-opened (on or after 3/9/2020).

Covariates

Within the case-control study, covariates were defined as previously described. Briefly, age, sex and Scottish Index of Multiple Deprivation (SIMD, an area based measure of socio-economic deprivation) were obtained from the CHI database, ethnicity was derived via self-report via a range of healthcare utilisation databases (Scottish Morbidity Records 01, 02 and 04) and comorbidity was obtained using previous hospitalisation (SMR01) and drug dispensing (PIS) data using definitions developed previously.[5]

[4] https://www.bmj.com/content/371/bmj.m3582
[5] https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003374

Statistical analysis

Summary statistics for demographic, socio-economic and clinical characteristics were calculated for teachers, healthcare workers and the remaining working-age population. The control arm of the case-control study is effectively a stratified random sample from the entire Scottish population, where the strata are defined by the age, sex and the GP practice within which each individual was registered. As such, if the probability of inclusion is known, the control arm can be used to obtain valid estimates for the whole population; this is analogous to the re-weighting used when analysing survey data.

To estimate the inclusion probabilities, we obtained age (in single years), sex, SIMD and health board area-specific counts of the general Scottish population from NRS 2019 mid-year estimates, and produced similar counts for the control arm of the case-control study. The inclusion probability for any individual was then calculated as the latter count divided by the former. Very similar results were obtained on weighting by the age-sex-GP practice distribution. We then produced whole-Scotland statistics for all teachers, healthcare workers and the remaining working-age population using the TableOne package in R which implements probability weighting for a range of summary statistics (including counts, proportions, means and standard deviations).

We produced plots of testing rates for each week, as well as cumulative incidence (risk) plots for the first test in an individual. We also produced cumulative incidence plots for individuals meeting the case definition (largely met via testing positive) and hospitalisation with COVID-19 for all three groups, stratifying by age and sex alongside confidence intervals derived via the log-cumulative hazard.

Since testing data for the entire working-age population were not readily available, the testing rates were estimated using the control arm of the case-control study and presented within age and sex strata (since the control arm is a stratified random sample of the Scottish population). This is likely to slightly over-estimate the testing rates as general practice areas where COVID-19 is more common are more likely to be included in the case-control study (since this was one of the matching variables), however, this effect is likely to be similar across all three groups. For cases and hospitalisations, however, all events for Scotland are included in the case arm of the case-control study and the denominators were obtained

directly for teachers and healthcare workers, and for the working-age population via subtraction (population = mid-year estimates – teachers – healthcare workers).

'Unadjusted' conditional logistic regression models were fitted using the survival package in R to calculate the hazard ratios conditional on age, sex, and general practice in which the person was registered. 'Adjusted' models were estimated where we also included terms for SIMD, ethnicity, the number of underlying conditions (such as comorbidities), and whether or not the individual shared a household with a healthcare worker in the regression models.

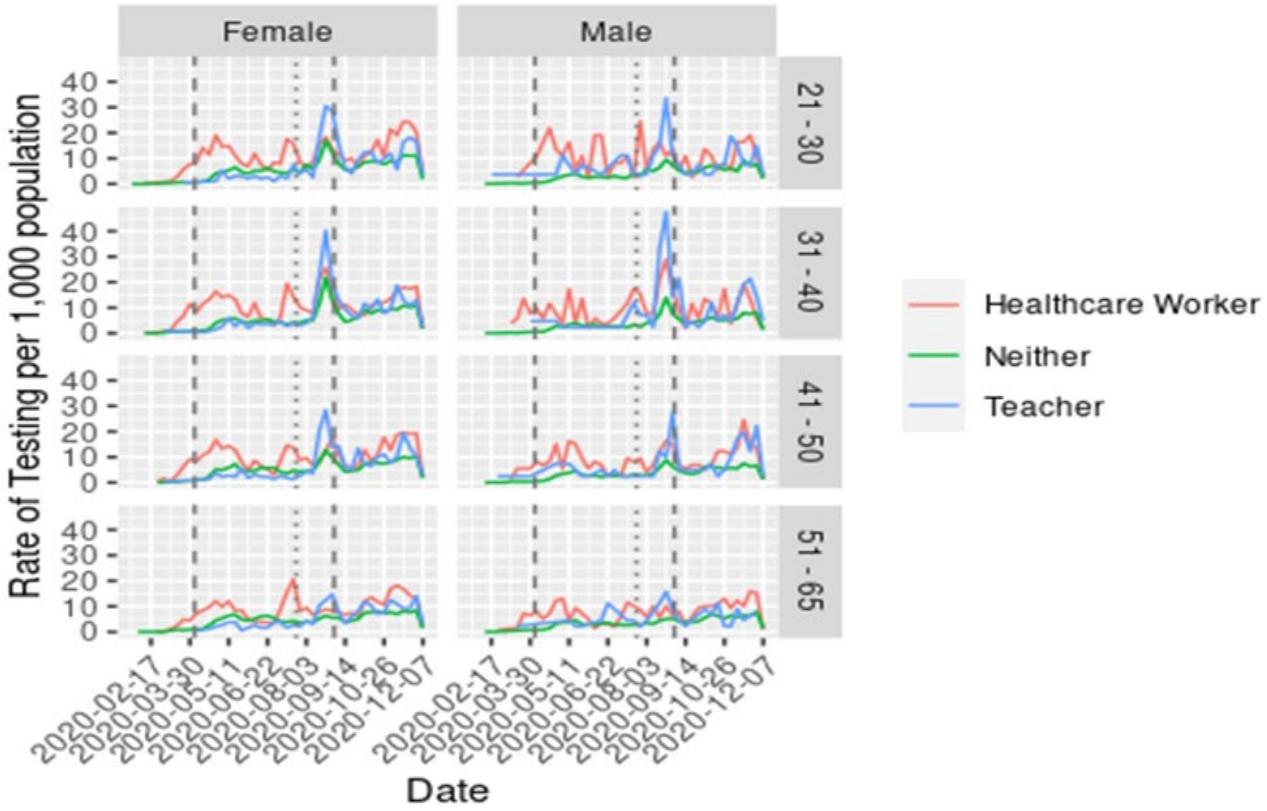
Results

There were 67,091 records of teachers currently, or believed to be, working at a Scottish school from the GTCS register data supplied to PHS, from the total GTCS register of more than 70,000 registrants. After de-duplication and after excluding records where the individual could not be linked to the CHI database (either due to errors or inconsistencies in recording), the final CHI-seeded teacher dataset included 66,710 unique individuals. Of these 11,147 were included in the 530,880-person case control study, with the number of healthcare workers being 24,139. Compared to the general population, teachers and healthcare workers were similar in terms of age and ethnicity, but were more likely to be women, and to have a lower prevalence of comorbidities. Both teachers and healthcare workers were less likely to be in the most deprived quintile for SIMD than were the general population, with a larger difference for teachers. Within teachers, those in secondary-school settings were least likely to be women. Even among this group, however, two thirds were women (see Appendix Table 1 for characteristics of controls).

Testing

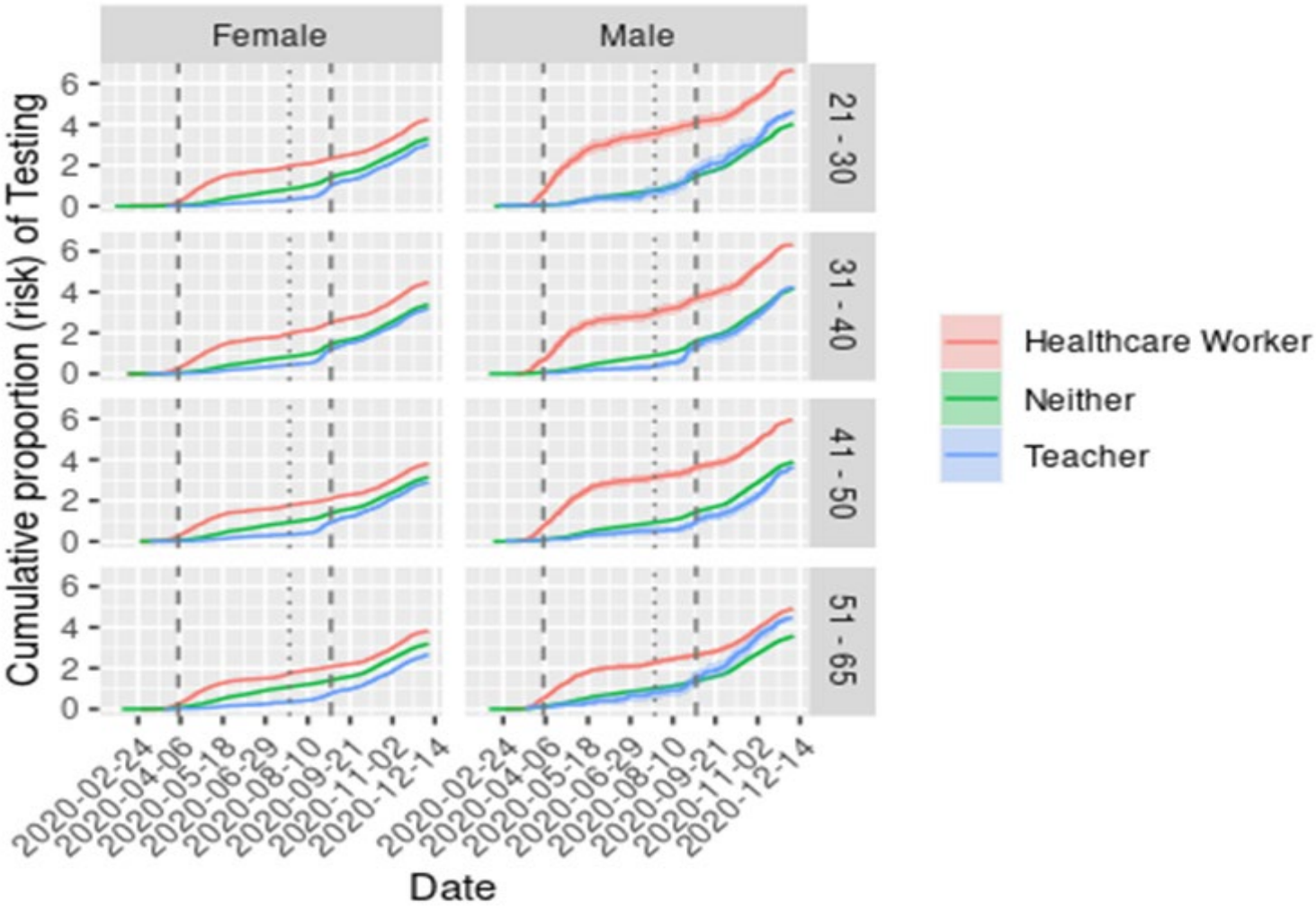
Testing for SARS-CoV-2 was highest in August for all three groups, but was particularly high among teachers (Figure 1). At the early stage of the restrictions teachers were least likely to be tested for SARS-CoV-2 but the probability of being tested increased rapidly during the late-stage restrictions and re-opening stage (Figure 2, Appendix Table 2). The increase in testing was particularly marked in younger male teachers.

Figure 1: Rate of COVID-19 PCR testing per 1,000, by age, sex and occupation



The vertical lines indicate the transitions between the pandemic periods described in the methods section – before schools closed, spring/summer restrictions, summer/autumn restrictions, schools re-opened.

Figure 2: Cumulative percentage of individuals tested for COVID-19 (PCR), by age, sex, and occupation



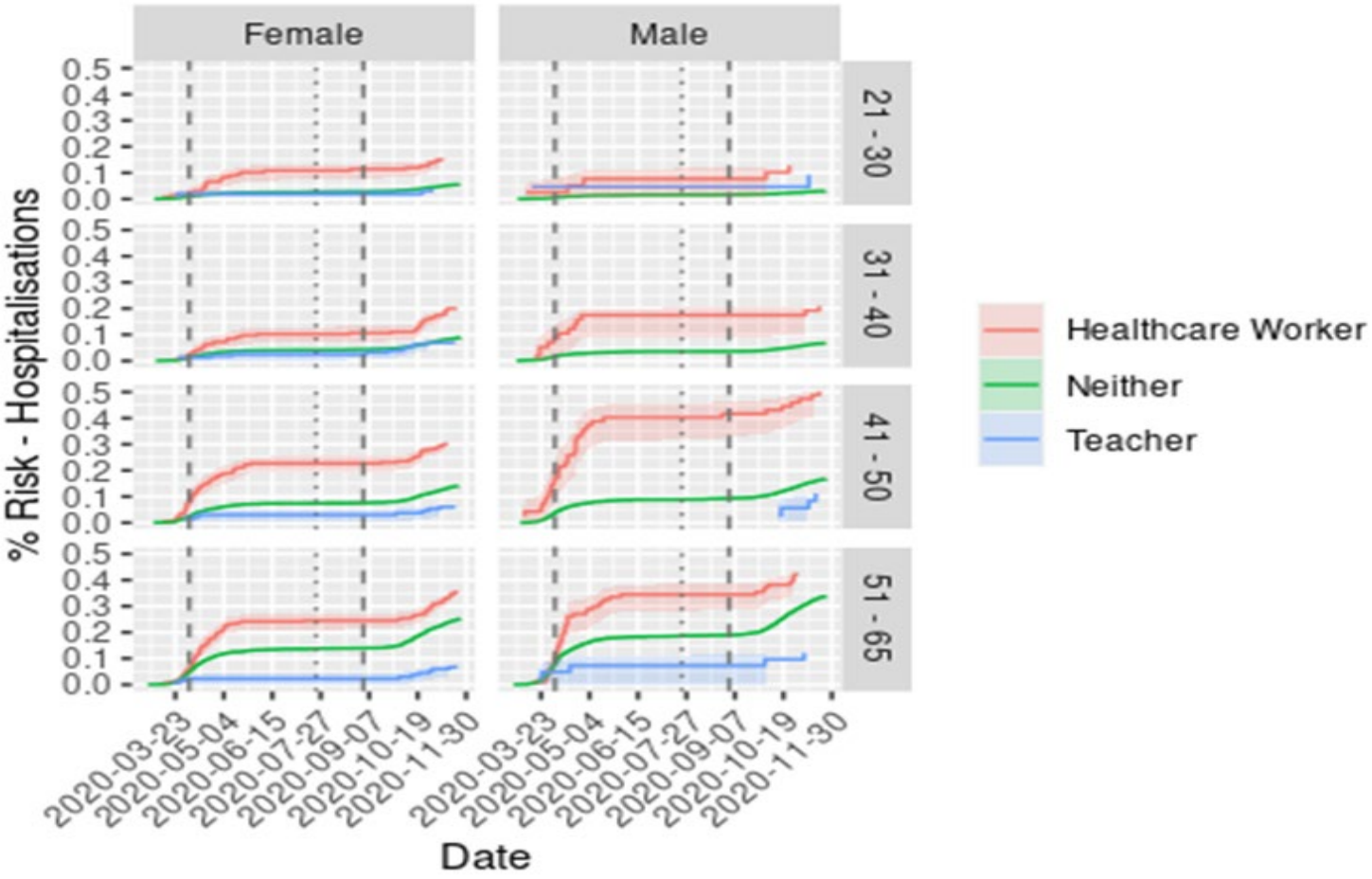
The vertical lines indicate the transitions between the pandemic periods described in the methods section – before schools closed, spring/summer restrictions, summer/autumn restrictions, schools re-opened.

Hospitalisation

Over the full study period, teachers were at lower risk of hospitalisation with COVID-19 than either healthcare workers or the general working-age population of Scotland (Appendix Table 3, Figure 3). This was found in models which conditioned on age, sex and general practice, as well as after additionally adjusted for ethnicity, SIMD, comorbidity and sharing a household with a healthcare worker. In the adjusted models, during the period after schools re-opened to the majority of pupils the risk was not lower, but nor was there evidence that the risk of hospitalisation with COVID-19 was increased for teachers (2/316).

For healthcare workers the risk remained elevated throughout the entire study period (following school re-opening 5/582). There was no evidence that the hazard ratios for hospitalisation with COVID-19 differed across settings for teachers, nor by age and sex.

Figure 3: Cumulative incidence (risk) of COVID-19 hospitalisation, by age, sex and occupation



The vertical lines indicate the transitions between the pandemic periods described in the methods section – before schools closed, spring/summer restrictions, summer/autumn restrictions, schools re-opened.

As these were conditional logistic regression model 'unadjusted' models were nonetheless conditional on age, sex and general practice of registration. Adjusted models included terms for ethnicity, SIMD, comorbidity counts and sharing a household with a healthcare worker.

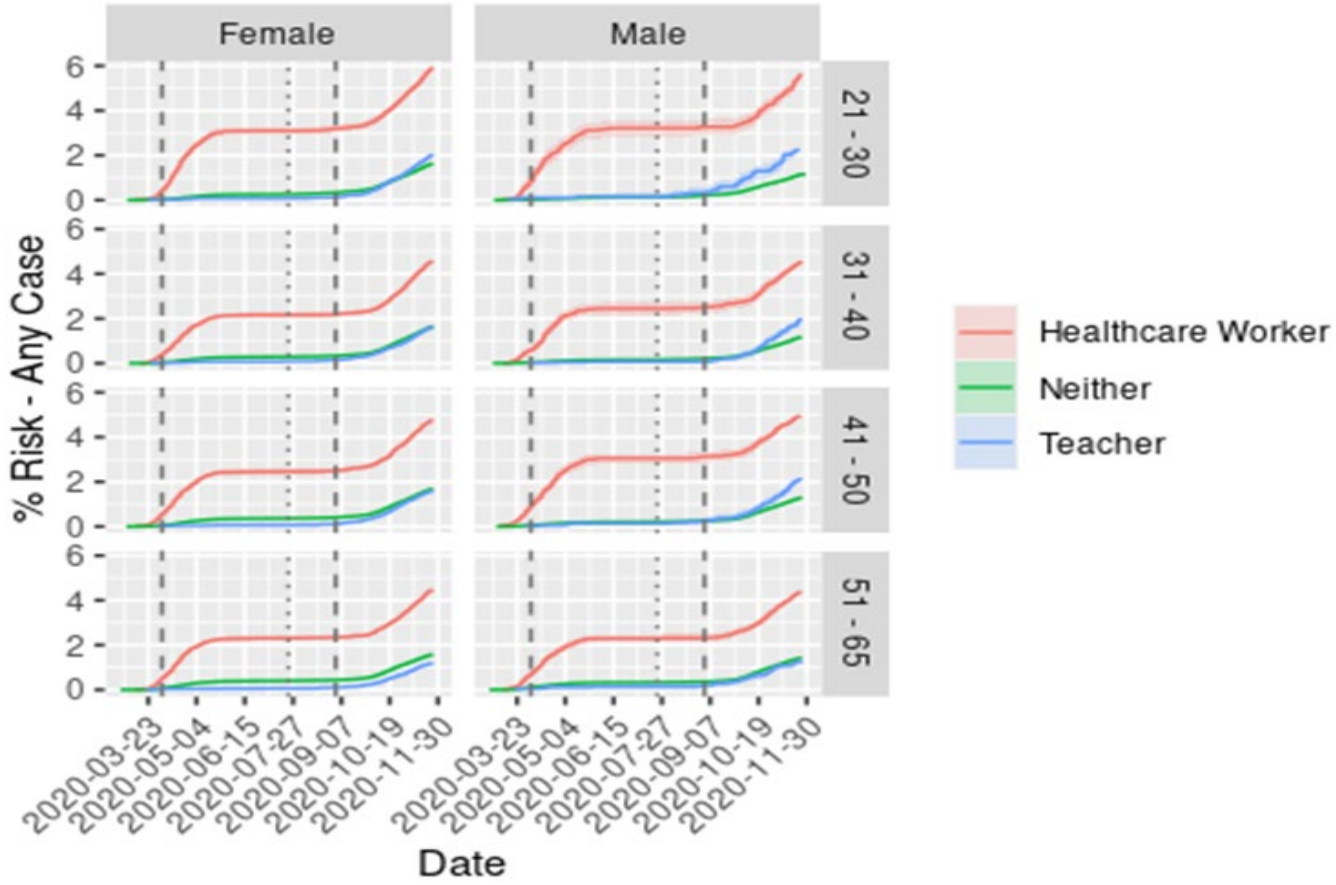
Testing positive for COVID-19

In contrast with hospitalisation, there was evidence of an increased risk of meeting the case-definition for COVID-19 among teachers compared to the general working-age population on conditioning on age, sex and general practice (1.24; 95% CI 1.16–1.32), as well as after adjusting for the full set of covariates described above (1.25; 95% CI 1.17–1.33). The risks of being a case was similar regardless of sector, with no evidence that either nursery or secondary-school teachers were at increased risk compared to teachers in other settings (Appendix Table 4).

The risk increased throughout the study period from a very low level during the early-stage restrictions (reflecting the very low level of testing outwith frontline healthcare workers at this stage), rising during the late-stage restrictions just before schools re-opened to all pupils (Appendix Table 4 and Figure 4) and highest when schools re-opened. Unlike with hospitalisation, the (relative) risk of being a case appeared to be lower in older teachers compared to younger teachers (Appendix Table 4 and Figure 4).

It is expected that a relatively constant proportion of all cases will be admitted to hospital, however the proportion of all cases that are detected by symptomatic testing has varied according to testing policy and access. As such the rate of hospitalisation is less subject to ascertainment bias (where rates appear to differ because of differences in the way in which cases are detected) than the rate of testing positive. This may explain why the hazard ratio for testing positive was so much higher than that for hospitalisation for healthcare workers and teachers, in different periods. Compared to rates in the remainder of the working-age population, for healthcare workers relative test positive rates greatly exceeded relative hospitalisation rates during the early pandemic (where testing was targeted at healthcare workers); whereas for teachers test positive rates exceeded hospitalisation rates during August and September (where testing among teachers was more common) (Figure 1).

Figure 4: Cumulative incidence (risk) of becoming a COVID-19 'case'



The vertical lines indicate the transitions between the pandemic periods described in the methods section – schools open, early restrictions, late restrictions, schools re-opened.

Severe COVID-19

The number of teachers and healthcare workers with severe COVID-19 was expected to be low because this outcome is rare, the number of teachers and healthcare workers compared to the general population is small, and the individuals under study are at lower risk because they are of working age. As such, although this was the main outcome for some analyses using the case-control study, we had not planned to focus on severe COVID-19 for the current project.

On examining this association, however, we found that compared to members of the general Scottish working-age population, the hazard ratio (adjusting for the same covariates as the fully adjusted model described above) was slightly increased for healthcare workers (1.08;

95% CI 0.87–1.35) overall, but that the increase was statistically significant only during the early stages of the pandemic (1.75; 95% CI 1.09–2.81, Appendix Table 5). In contrast, teachers were found to be at lower risk of COVID-19 than the general population throughout the pandemic (0.50; 95% CI 0.30–0.82, Appendix Table 5), including during the period after schools re-opened (0.46; 95% CI 0.23–0.92), with confidence intervals that did not cross one, indicating that teachers are likely to be at lower risk of severe COVID-19 than the general Scottish working-age population.

Discussion

What this report adds

This report provides an estimation of the risk of COVID-19 infection and illness in teachers, based on a Scotland-wide dataset, covering the period from the first case in Scotland to 26 November 2020. The risk is compared to that of other members of the working-age population, and takes account of other factors which may influence risk of COVID-19, such as age, sex, socio-economic deprivation and pre-existing health conditions. Previous work on the risk of healthcare workers means it is also possible to compare to this group.

Risk of hospitalisation and severe COVID-19

Across the whole period teachers were at lower risk of both hospitalisation with COVID-19, and of severe COVID-19 (defined where an individual was admitted to intensive care or died within 28 days of testing positive for SARS-CoV-2), than the general population. In the period since schools re-opened in August 2020 through to November 2020, there was no evidence of a difference in the risk of hospitalisation between teachers and the general population and the risk of severe COVID-19 was lower among teachers.

Risk of hospitalisation provides a relatively stable measure over time of significant COVID-19 related illness, as it is less likely to be influenced by policy and access to care. From the perspective of assessing any occupational risk, it is reassuring that teachers do not appear to have been at increased risk of hospitalisation, compared to the general population, since schools returned in August. In addition, their risk of severe COVID-19 was considerably lower, at around half, and this difference was statistically significant at the conventional level. By contrast, the healthcare workers continue to be at increased risk of hospitalisation.

Risk of testing positive for COVID-19 infection (SARS-CoV-2)

The results for the whole period show that the risk of becoming a COVID-19 case was higher among teachers than the general population. This outcome counts those who test positive, those who are admitted to hospital, intensive care, or who die. Since there was no increase in hospitalisation, intensive care unit admission or death, this difference can be attributed to an increase in the risk of testing positive for SARS-CoV-2. This risk varied over time, with a lower risk of testing positive pre-closure, and in lockdown, and no difference in risk after easing of restrictions but before schools re-opened. Following the re-opening of schools, teachers' risk of testing positive was higher than the general population.

The likelihood of testing positive is influenced both by the likelihood of infection, and by the likelihood of having this infection confirmed with a test. Access to testing has changed over the course of the pandemic, and use of testing may also be influenced by behavioural factors. The impact of this can be seen in the differences in the risk of testing positive in the period before school closure. The results for this period show that healthcare workers were more than 10 times more likely to have a positive test than the general population. Although this is likely to reflect occupational risk to some extent (as risk of hospitalisation was also higher) it is also partly explained by the fact that healthcare workers had greater access to testing, as the majority of cases in the community among the general population were not tested at that time.

In the period since schools reopened, rates of testing have been relatively high among teachers, and therefore some of the increased risk of testing positive may be explained by this increase in testing. This explanation is particularly likely since the ONS survey, which employed random sampling, found no evidence of any difference in risk of testing positive among teachers, compared to other professions. Nonetheless, teaching is an occupation which involves in-person working in settings with large numbers of other people. As such, some of the increased risk of testing positive may reflect this exposure, especially as the general population comparison group will contain those who have changed their working practices to minimise contact with others. Regardless of whether the increase in testing positive is solely due to increased testing, or is also a result of increased exposure, it is reassuring that the higher risk of testing positive is not seen in the 51–65 year age groups, and that it is not associated with a higher risk of hospitalisation or severe COVID-19.

Limitations

A small number of teachers are not registered with the GTCS; a small number asked for their records not to be shared; a small number of registrants could not be linked to healthcare records, and among those who were a small number of linkages may have been incorrect linkages where different individuals appeared to be the same individual in different databases (known as mal-linkage). For this reason, the numbers in this report will not match exactly with other work produced by PHS based on detailed reporting from individual cases. Nonetheless, these discrepancies are highly unlikely to have affected the overall estimates of differences between teachers, healthcare workers and other working-age adults presented here. This was a large and largely complete sample of teachers, and crucially the outcome data was obtained in the same manner for the different occupational groups such that valid and comparisons can be made between them, especially for outcomes such as hospitalisation and admission to intensive care.

Unfortunately, we are not currently able to compare the risk of teachers to other, non-healthcare, in-person occupations, such as police, social care or retail, as these occupational data are not available to PHS. Such analyses would help further contextualise the risks among teachers and healthcare workers. Similarly, it was not possible to include non-teaching education staff in this analysis, as there is no comparable data source to the GTCS register to provide information on other staff groups.

Other population-based comparisons

Several other sources provide additional information on the risk of COVID-19 infection among school workers in the UK. On 6 November data were presented from the UK-wide Office for National Statistics (ONS) COVID-19 infection survey, which found no evidence of any difference in COVID-19 positivity rates between teachers and other professions in England.[6] These results included data from 2 September to 16 October, covering the period after the return to school, and also found no evidence of any difference in positivity rate between teachers in a range of settings, and education support staff.

[6] www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/coronaviruscovid19infectionsurveypilot/6november2020#analysis-of-the-number-of-school-workers-key-workers-and-other-professions-in-england-who-had-covid-19

The ONS has also presented data on deaths from COVID-19 by occupational group for the whole of the UK, with the National Records for Scotland (NRS) presenting similar data for Scotland. In the most recent ONS mortality data by occupation, which covered the period from March to May 2020 those recorded as teaching and education professionals were not found to be at a higher risk of death with COVID-19 than the overall population aged 20–64 years. In Scotland, the National Records for Scotland reported that there have been four deaths with COVID-19 among teachers up to 31 October 2020, but did not calculate rates or provide comparisons against other occupations.

PHS are also undertaking a survey to monitor the proportion of the population working in education who have antibodies to SARS-CoV-2. The first results of this survey are published in conjunction with this report, and reported in the summary document.

Summary

The results reported here provide reassurance that there is no evidence that teachers have been at increased risk of hospitalisation with COVID-19 in the two periods when in-person teaching has been taking place since the start of the pandemic (March 2020, and since mid-August 2020). The risk of testing positive has been higher among teachers than the general population. PHS will continue to monitor these outcomes, and future analysis with more additional data may permit more detailed analysis by job role and location.

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Further information

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Appendix 1 – Early access details

Pre-Release Access

Under terms of the 'Pre-Release Access to Official Statistics (Scotland) Order 2008', PHS is obliged to publish information on those receiving Pre-Release Access ('Pre-Release Access' refers to statistics in their final form prior to publication). The standard maximum Pre-Release Access is five working days. Shown below are details of those receiving standard Pre-Release Access.

Standard Pre-Release Access:

- Scottish Government Health Department
- NHS Board Chief Executives
- NHS Board Communication leads

Appendix 2 – PHS and Official Statistics

About Public Health Scotland (PHS)

PHS is a knowledge-based and intelligence-driven organisation with a critical reliance on data and information to enable it to be an independent voice for the public's health, leading collaboratively and effectively across the Scottish public health system, accountable at local and national levels, and providing leadership and focus for achieving better health and wellbeing outcomes for the population. Our statistics comply with the Code of Practice for Statistics in terms of trustworthiness, high quality and public value. This also means that we keep data secure at all stages, through collection, processing, analysis and output production, and adhere to the 'five safes'.