Comparative symptomatology of infection with SARS-CoV-2 variants Omicron (B.1.1.529) and Delta (B.1.617.2) from routine contact tracing data in England

Alice K. E. Ekroth, Piotr Patrzylas, Charlie Turner, Gareth J. Hughes and Charlotte Anderson

Health Protection Operations, Field Services, Contact Tracing Data Management and Surveillance, UK Health Security Agency, London, England

Abstract
Symptoms are currently used as testing indicators for SARS-CoV-2 in England. In this study, we analysed national contact tracing data for England (NHS Test and Trace) for the period 1 December to 28 December 2021 to explore symptom differences between the variants, Delta and Omicron. We found that at least one of the symptoms currently used as indicators (fever, cough and loss of smell and taste) were reported in 61.5% of Omicron cases and 72.2% in Delta cases, suggesting that these symptoms are less predictive of Omicron infections. Nearly 40% of Omicron infections did not report any of the three key indicative symptoms, reinforcing the importance of the entire spectrum of symptoms for targeted testing. After adjusting for potential confounding factors, fever and cough were more commonly associated with Omicron infections compared to Delta, showing the importance of considering age and vaccination status when assessing symptom profiles. Sore throat was also more commonly reported in Omicron infections, and loss of smell and taste more commonly reported in Delta infections. Our study shows the value of continued monitoring of symptoms associated with SARS-CoV-2, as changes may influence the effectiveness of testing policy and case ascertainment approaches.

Introduction
The emergence of new SARS-CoV-2 variants has been associated with changes to transmission dynamics and clinical presentation. The emergence of the Alpha variant in September 2020 [1] was associated with a 43–90% increase in observed transmission compared to the original wildtype strain [2]. Similarly, transmission of the Delta variant, detected in April 2021, was found to be 40–60% higher than for Alpha [3]. During December 2021 and January 2022 in England, Omicron emerged, overtaking Delta as the dominant variant [4]. Recognising symptom differences between emerging SARS-CoV-2 variants and other circulating respiratory infections, and how this may vary between groups such as children or vaccinated populations, could help to identify suitable clinical predictors to inform testing policy. In addition, monitoring changes in symptoms will help to better understand the links between genetic diversity, transmission parameters and clinical presentation.

The first reported indicative symptoms of COVID-19 were fever, cough and loss of smell and taste [5, 6]. Since then, a wide range of symptoms have been reported. A UK study explored symptoms of cases from April 2020 to August 2021, from when wild-type, Alpha and then Delta were circulating [7]. The study reported a greater number of Delta cases experiencing fever, headache and sore throat compared to Alpha, but concluded that the changes observed did not support changes to targeted symptom-based testing [7]. Similarly, one London-based survey (up until 11 December 2021) did not identify a clear difference in symptom profile between early Omicron cases and those with Delta infections [8]. They found the most common symptoms associated with a Delta infection were headache for fully vaccinated, sore throat for partially vaccinated and runny nose/sneezing for unvaccinated positive cases, and no clear early symptom difference between this and Omicron [9]. Another UK survey comparing symptomatic PCR-positive and PCR-negative cases found a marked reduction in reporting of loss of smell and taste, and an increase in sore throat. This survey covered PCR-positives from early to late December 2021, when England moved from a dominant Delta to Omicron [10]. However, over the same period sore throat became more commonly reported in symptomatic PCR-negative cases. Taken together with the reduction of previously specific symptoms, this indicates that monitoring of specific symptoms is necessary for effective testing strategies.
Here we report the use of routine data on symptoms collected during contact tracing in England to compare the symptom profile of Omicron and Delta infections to inform testing and response strategies.

Methods

Study population and data sources

Case data were obtained from a routine, national contact tracing system (NHS Test and Trace) where cases were defined as people testing positive for SARS-CoV-2 by PCR and referred for contact tracing. Contact tracing in England was a national system, operating at a whole population level where an online form was completed by the case or on the phone by a contact tracer. Symptom data were entered only once and could not be revised following collection. Inputted dates and postcodes were validated at point of entry. Data were obtained from a full extract of the live contact tracing data that were used for analytical purposes. During contact tracing, all cases were asked if they had had or were experiencing any of the following symptoms: fever, cough, shortness of breath, fatigue, altered consciousness, muscle or joint pain, headache, loss of smell or taste, sore throat, runny nose, sneezing, rash, red or irritated eye, loss of appetite, nausea or vomiting, or diarrhoea. A case was defined as symptomatic if at least one symptom was reported at the time of contact tracing.

Variants were defined by genomic sequencing and genotyping of PCR-confirmed cases and detected based on the UKHSA’s single and multi-nucleotide polymorphisms variant definitions with targets for VOC-21APR-02 (Delta) and VOC-21NOV-01 (Omicron) genomes [4]. All symptomatic Omicron and Delta cases reporting symptoms between 1 and 28 December 2021 were included, excluding those who did not complete contact tracing or had missing age, sex, geographical region or vaccination status. Vaccination status was determined by linking contact tracing data to the National Immunisation Management System (NIMS) [11] using combinations of NHS number, forename, first initial, surname, date of birth and postcode. Vaccination status was defined by the number of doses received by the time of symptom onset, allowing some delay for protection from the most recent vaccine dose. Categories 1 dose + 21 days, 2 doses + 14 days and 3 doses + 14 days were used, as in UKHSA vaccine surveillance reports [12].

Data analysis

The number of symptoms reported by symptomatic cases with each variant was calculated as medians with interquartile ranges (IQR). Differences in reporting of symptoms (days) relative to symptom onset were assessed using a Mann–Whitney U test between variants. The number and proportions of cases reporting each symptom were described by variant, age group (0–4, 5–11, 12–18, 19–39, 40–59, ≥60 years), sex, ethnicity, vaccination status, date of reported symptom onset and geographical region. Differences in the distribution of co-variables and symptoms by variant were assessed using Pearson’s χ² tests.

Multivariable logistic regression models were used to estimate adjusted associations between reported symptoms and infection with Omicron compared to Delta. Two modelling approaches were adopted: (1) where reported symptom was the outcome and variant the co-variable of interest and (2) where variant was the outcome and each symptom the co-variables of interest. All variables included in the main effects model were selected a priori, consistent with other studies which have considered symptom profiles [7, 10, 13]. Associations were adjusted for age group, sex, ethnicity, vaccination status, geographical region and the week in which symptoms began to adjust for potential confounding. Geographical region and the week in which symptoms began were included as proxy indicators for any impact of other circulating respiratory viruses which can cause similar symptoms to SARS-CoV-2 and may have differential activity by region over short time periods. For modelling approach (1) we undertook stratified analysis by age group (0–4, 5–11, 12–18, 19–39, 40–59, ≥60 years) adjusted for the same co-variables as the main model for all age groups other than 0–4 and 5–11 years where vaccination status was excluded.

The assumption of missingness completely at random for missing data was assessed using Little’s Missing Completely at Random (MCAR) test using the function mcar.test. Multivariate Imputation by Chained Equation (MICE) was used for imputation of missing values (five replicate datasets). Pooled analysis was used to produce associations and P values for imputed data using the pool function in the package mice which were compared to the analysis of complete observations only. For modelling approach (2) goodness of fit was assessed using a case classification table with a cut-off of 0.5.

All statistical analysis was carried out in R version 4.1.2 (R Core Team 2021).

Results

Descriptive analysis

There were 2 376 049 cases reported to the contact tracing system during the period 1–28 December 2021. Of these, a total of 309 912 were confirmed Omicron and 123 529 confirmed Delta cases. Of these, 224 451 symptomatic Omicron cases and 89 328 symptomatic Delta cases had completed contact tracing. After removal of cases with incomplete data for age (n = 7), sex (n = 187), geographical region (n = 2205) and vaccination status (for those aged 12 or older, n = 12 458), the final dataset contained 213 305 (68.8% of total confirmed Omicron cases) Omicron and 85 846 (69.4% of total confirmed Delta cases) Delta cases.

Cases with Delta infection were more likely to be children: 32% of those with Delta were aged under 18 years old, compared to 9.6% of Omicron cases (Table 1). Omicron cases were more likely to have had three vaccine doses compared to Delta cases (21.4–4.6%), and Delta cases (36.9%) were more likely to be unvaccinated than Omicron cases (13.8%). Also, cases with Omicron were more likely to be resident in London (22.5%, compared to 11.0% of Delta cases).

The median total number of symptoms reported by cases was 4 for both Omicron and Delta (IQR: 2.0–6.0). There was a significant difference between symptom onset and completing contact tracing between variants (Mann–Whitney U test; W = 7 434 461).
where Omicron cases had a median of 3.97 days (IQR: 2.85–5.90 days) and Delta a median of 3.09 days (IQR: 2.03–4.93 days).

For the key symptoms used as SARS-CoV-2 infection predictors (fever, cough and loss of smell and taste), 61.5% of Omicron and 72.1% of Delta cases reported at least one of these symptoms. The crude proportion of cases reporting loss of smell and taste was lower in Omicron (13.4%) than Delta (33.7%). Fever was also reported slightly less often in Omicron (29.2%) than Delta (32.7%). A similar crude proportion of cases reported cough for each variant (Omicron: 44.6%; Delta: 44.0%).

The most common symptom reported was headache, with 56.2% for Omicron and 55.5% for Delta. The next most common symptom for Omicron was sore throat (53%), followed by runny nose (51%). For cases with Delta, the next most common symptoms were runny nose (49%) and cough (44%).

Overall, when comparing crude values, we found that all symptoms (except rash) were significantly different between variants (Table 2).

| Characteristic | Category | Delta (% a) | Omicron (% a) | \( \chi^2 \) (P value) |
|----------------|----------|-------------|---------------|-----------------|
| All cases      |          | 85 846 (28.7%) | 213 305 (71.3%) | 313 952 (<0.001) |
| Age group (years) | 0–4      | 2350 (2.7%) | 1660 (0.8%) |                   |
|                | 5–11     | 16 691 (19.4%) | 6630 (3.1%) |                   |
|                | 12–18    | 8461 (9.9%) | 12 242 (5.7%) |                   |
|                | 19–39    | 25 434 (29.6%) | 107 308 (50.3%) |                   |
|                | 40–59    | 28 226 (32.9%) | 65 244 (30.6%) |                   |
|                | ⩾60      | 4684 (5.5%) | 20 221 (9.5%) |                   |
| Sex            | Female   | 45 927 (53.5%) | 117 245 (55.0%) | 53.0 (<0.001) |
|                | Male     | 39 919 (46.5%) | 96 060 (45.0%) |                   |
| Ethnic group   | White    | 72 219 (84.1%) | 171 108 (80.2%) | 1893.0 (<0.001) |
|                | Asian or Asian British | 4775 (5.6%) | 15 915 (7.5%) |                   |
|                | Mixed or multiple ethnic groups | 1978 (2.3%) | 5629 (2.6%) |                   |
|                | Black, African, Caribbean or Black British | 1274 (1.5%) | 8593 (4.0%) |                   |
|                | Not stated or prefer not to say | 4739 (5.5%) | 9258 (4.3%) |                   |
|                | Other ethnic group | 861 (1.0%) | 2802 (1.3%) |                   |
| Vaccination status\(^b\) | 1 dose + 21 days | 5454 (6.4%) | 10 127 (4.7%) | 28 223.5 (<0.001) |
|                | 2 doses + 14 days | 43 887 (51.1%) | 127 464 (59.8%) |                   |
|                | 3 doses + 14 days | 3957 (4.6%) | 45 720 (21.4%) |                   |
|                | Unlinked | 849 (1.0%) | 599 (0.3%) |                   |
|                | Unvaccinated | 31 699 (36.9%) | 29 395 (13.8%) |                   |
| Symptom week\(^c\) | 01/12/2021 | 50 893 (59.3%) | 5271 (2.5%) | 151 463.0 (<0.001) |
|                | 08/12/2021 | 25 887 (30.2%) | 50 151 (23.5%) |                   |
|                | 15/12/2021 | 7154 (8.3%) | 70 906 (33.2%) |                   |
|                | 22/12/2021 | 1912 (2.2%) | 86 977 (40.8%) |                   |
| Region         | East Midlands | 6604 (7.7%) | 15 923 (7.5%) | 10 866.3 (<0.001) |
|                | East of England | 9719 (11.3%) | 17 297 (8.1%) |                   |
|                | London | 9479 (11.0%) | 47 952 (22.5%) |                   |
|                | North East | 3986 (4.6%) | 8013 (3.8%) |                   |
|                | North West | 6908 (8.0%) | 26 285 (12.3%) |                   |
|                | South East | 21 668 (25.2%) | 48 096 (22.5%) |                   |
|                | South West | 17 557 (20.5%) | 22 342 (10.5%) |                   |
|                | West Midlands | 5513 (6.4%) | 14 441 (6.8%) |                   |
|                | Yorkshire and Humber | 4412 (5.1%) | 12 956 (6.1%) |                   |

\(^a\) Row percentages.

\(^b\) Vaccination status was defined by the number of doses received by the time of symptom onset, allowing some delay for protection from the most recent vaccine dose.

\(^c\) Symptom week encompasses cases reported between Wednesdays listed and the following Tuesdays during the month of December.
Variations in symptom profile between cases infected with the Omicron and Delta variants were observed in some age groups (Table 2). After conducting a stratified analysis by age group, we found that fever was more commonly reported by Omicron cases compared to those with Delta (Fig. 1, aOR 1.17, 95% CI 1.14–1.20, P < 0.001); this had been confounded by age and vaccination status. Crude proportions suggested that cough was similarly reported between variants, however, after adjustment, it was found to be more commonly associated with Omicron infection (Fig. 1, aOR 1.16, 95% CI 1.14–1.18, P < 0.001). Finally, muscle ache or joint pain (Fig. 1, aOR 1.07, 95% CI 1.02–1.12, P = 0.010) were slightly more commonly reported by Omicron cases.

The findings from modelling approach (2) are consistent of those from modelling approach (1). Adjusted associations between variant and symptoms and conversely, symptoms with variant, are similar in direction and relative magnitude (Table 3). Evaluation of fit for modelling showed high specificity (0.912) but low sensitivity (0.431), indicating that symptoms alone (and adjustment for important co-variables) are not able to adequately distinguish between infection with Delta and Omicron variants.

Stratified analysis

Variations in symptom profile between cases infected with the Omicron and Delta variants were observed in some age groups (Fig. 2). After conducting a stratified analysis by age group, we positively associated with Delta infections (Fig. 1, aOR 0.92, 95% CI 0.90–0.94, P < 0.001).

We found sore throat (Fig. 1, aOR 1.89, 95% CI 1.84–1.94, P < 0.001) was more strongly associated with Omicron infection. Although the crude proportion was lower, after adjustment we found that fever was more commonly reported by Omicron cases compared to those with Delta (Fig. 1, aOR 1.17, 95% CI 1.14–1.20, P < 0.001); this had been confounded by age and vaccination status. Crude proportions suggested that cough was similarly reported between variants, however, after adjustment, it was found to be more commonly associated with Omicron infection (Fig. 1, aOR 1.13, 95% CI 1.11–1.16, P < 0.001). Finally, muscle ache or joint pain (Fig. 1, aOR 1.04, 95% CI 1.02–1.12, P = 0.010) and diarrhea (Fig. 1, aOR 1.07, 95% CI 1.02–1.12, P = 0.010) were slightly more commonly reported by Omicron cases.

Multivariable analysis

Little’s MCAR test indicated that the assumption of missingness completely at random was not met (P value < 0.001). For both modelling approaches, results from analysis using imputed values were practically identical to those from the complete case analysis (results not shown). The only noted difference was a very small reduction in aOR for modelling approach (1) for diarrhoea (1.07 (CI 1.02–1.12) to 1.06 (CI 1.01–1.12)). Given this finding, results are presented herein using data with complete values only.

Significant differences in the symptom profile between cases infected with the Omicron and Delta variants of SARS-CoV-2 were observed in routine contact tracing data. After adjustment for age group, sex, ethnicity, vaccination status, geographical region and the week in which symptoms began, where the reference group was Delta.

**Table 2. Symptom frequency and crude and adjusted association of variant with symptoms**

| Symptom                             | Delta     | Omicron   | \( \chi^2 \) (P value) | OR (95% CI) | P value | aOR* (95% CI) | P value |
|-------------------------------------|-----------|-----------|-------------------------|-------------|---------|---------------|---------|
| Sore throat                         | 29 531 (34.4%) | 113 552 (53.2%) | 8701.3 (<0.001) | 2.17 (2.14–2.21) | <0.001 | 1.89 (1.84–1.94) | <0.001 |
| Fever                               | 28 084 (32.7%) | 62 211 (29.2%) | 365.7 (<0.001) | 0.85 (0.83–0.86) | <0.001 | 1.17 (1.14–1.20) | <0.001 |
| Cough                               | 37 741 (44.0%) | 95 221 (44.6%) | 11.3 (<0.001) | 1.03 (1.01–1.04) | <0.001 | 1.13 (1.11–1.16) | <0.001 |
| Diarrhoea                           | 5334 (6.2%) | 15 877 (7.4%) | 140.4 (<0.001) | 1.21 (1.18–1.25) | <0.001 | 1.07 (1.02–1.12) | 0.010 |
| Muscle ache or joint pain           | 33 476 (39.0%) | 95 076 (44.6%) | 776.8 (<0.001) | 1.26 (1.24–1.28) | <0.001 | 1.04 (1.02–1.07) | 0.001 |
| Rash                                | 1123 (1.3%) | 2729 (1.3%) | 0.38 (0.540) | 0.98 (0.91–1.05) | 0.528 | 1.03 (0.93–1.15) | 0.572 |
| Nausea or vomiting                  | 11 105 (12.9%) | 26 402 (12.4%) | 17.4 (<0.001) | 0.95 (0.93–0.97) | <0.001 | 1.01 (0.97–1.05) | 0.616 |
| Fatigue                             | 34 469 (40.2%) | 93 366 (43.8%) | 327.5 (<0.001) | 1.16 (1.14–1.18) | <0.001 | 0.98 (0.96–1.01) | 0.194 |
| Altered consciousness               | 3641 (4.2%) | 9602 (4.5%) | 9.7 (0.002) | 1.06 (1.02–1.11) | 0.002 | 0.94 (0.89–0.99) | 0.029 |
| Headache                            | 47 667 (55.5%) | 119 938 (56.2%) | 12.2 (<0.001) | 1.03 (1.01–1.05) | <0.001 | 0.92 (0.90–0.94) | <0.001 |
| Loss of appetite                    | 14 796 (17.2%) | 35 288 (16.5%) | 20.98 (<0.001) | 0.95 (0.93–0.97) | <0.001 | 0.87 (0.84–0.90) | <0.001 |
| Shortness of breath                 | 11 629 (13.5%) | 32 312 (15.1%) | 125.2 (<0.001) | 1.14 (1.11–1.17) | <0.001 | 0.86 (0.83–0.89) | <0.001 |
| Runny nose                          | 42 050 (49.0%) | 109 180 (51.2%) | 118.6 (<0.001) | 1.09 (1.07–1.11) | <0.001 | 0.81 (0.79–0.83) | <0.001 |
| Sneezing                            | 30 700 (35.8%) | 85 693 (40.2%) | 501.1 (<0.001) | 1.21 (1.19–1.23) | <0.001 | 0.81 (0.79–0.83) | <0.001 |
| Red or irritated eye                | 7848 (9.1%) | 15 829 (7.4%) | 248.6 (<0.001) | 0.80 (0.77–0.82) | <0.001 | 0.70 (0.67–0.73) | <0.001 |
| Loss of smell or taste              | 28 891 (33.7%) | 28 569 (13.4%) | 16 190.9 (<0.001) | 0.30 (0.30–0.31) | <0.001 | 0.23 (0.22–0.23) | <0.001 |

OR, odds ratio; aOR, adjusted odds ratio.

*aAssociations were adjusted for age group, sex, ethnicity, vaccination status, geographical region and the week in which symptoms began, where the reference group was Delta.*
found that children under 18 years had different symptom profiles compared to adults. However, sore throat was still more commonly associated with Omicron infection and loss of smell and taste with Delta infection across all age groups (Supplementary Table S1).

Variations in reported symptoms were found between some age groups. We found that, whilst fever was more commonly reported in Omicron cases, this was not observed in children under 5 years or adults ≥60 years (Fig. 2). Also, cough was more commonly associated with Omicron infection in adults (apart from 40–59 years) but not in children under 18 years (Fig. 2). Headache was more common in children over 4 years with Omicron infections and adults with Delta infections (Fig. 2). Whereas, muscle ache or joint pain was reported amongst

Table 3. Crude and adjusted associations for symptoms of infection with Omicron variant compared to Delta variant

| Symptom                        | OR (95% CI)       | P value | aOR (95% CI)    | P value |
|--------------------------------|-------------------|---------|----------------|---------|
| Sore throat                    | 2.17 (2.13–2.21)  | <0.001  | 1.87 (1.84–1.91)| <0.001  |
| Fever                          | 0.85 (0.83–0.86)  | <0.001  | 1.09 (1.07–1.11)| <0.001  |
| Cough                          | 1.03 (1.01–1.04)  | 0.001   | 1.03 (1.01–1.05)| 0.001   |
| Diarrhoea                      | 1.21 (1.18–1.25)  | <0.001  | 1.26 (1.22–1.31)| <0.001  |
| Muscle ache or joint pain      | 1.26 (1.24–1.28)  | <0.001  | 1.03 (1.01–1.06)| 0.002   |
| Rash                           | 0.98 (0.91–1.05)  | 0.528   | 1.20 (1.10–1.30)| <0.001  |
| Nausea or vomiting             | 0.95 (0.93–0.97)  | <0.001  | 1.10 (1.07–1.14)| <0.001  |
| Fatigue                        | 1.16 (1.14–1.18)  | <0.001  | 1.05 (1.03–1.08)| <0.001  |
| Altered consciousness          | 1.06 (1.02–1.11)  | 0.002   | 1.08 (1.04–1.13)| 0.001   |
| Headache                       | 1.03 (1.01–1.04)  | <0.001  | 0.84 (0.83–0.86)| <0.001  |
| Loss of appetite               | 0.95 (0.93–0.97)  | <0.001  | 1.12 (1.09–1.15)| <0.001  |
| Shortness of breath            | 1.14 (1.11–1.17)  | <0.001  | 1.01 (0.98–1.04)| 0.393   |
| Runny nose                     | 1.09 (1.07–1.11)  | <0.001  | 0.80 (0.78–0.82)| <0.001  |
| Sneezing                       | 1.21 (1.19–1.23)  | <0.001  | 0.91 (0.89–0.93)| <0.001  |
| Red or irritated eye           | 0.80 (0.77–0.82)  | <0.001  | 0.77 (0.74–0.80)| <0.001  |
| Loss of smell or taste         | 0.30 (0.30–0.31)  | <0.001  | 0.23 (0.23–0.24)| <0.001  |

OR, odds ratio; aOR, adjusted odds ratio.
children aged 5–18 with Omicron, with no evidence of a difference between variants in other age groups (Fig. 2). Shortness of breath, sneezing and loss of appetite were more common in all Delta adult cases (≥19 years) (Fig. 2). Other symptoms (rash, nausea or vomiting, red or irritated eye, altered consciousness, diarrhoea) showed little variation between age groups.

Discussion
With the likely continued emergence of SARS-CoV-2 variants, it is important to monitor for potential changes in clinical presentation of COVID-19. Here, we used data from England’s national contact tracing system to compare the symptomatology of cases infected with the Omicron and Delta variants. Collectively, we found that key symptom predictors (fever, cough and loss of smell and taste) were more commonly reported in Delta compared to Omicron cases. However, when symptoms were studied individually, we found that fever and cough were more commonly reported by Omicron cases and loss of smell and taste by Delta cases. However, caution should be used whilst interpreting these symptom profiles, given the tendency for highly statistically significant results when analysing large datasets. Understanding comparative symptom profiles, and the variance that may exist between SARS-CoV-2 variants, will help guide the development (and ongoing revision of) screening tools. For example, temperature screening has often been used as a measure to identify cases [14], however, only around 30% of Omicron cases reported fever. Symptom predictors may be limited in informing testing, where a focus on a wider set of symptoms would be far more beneficial.

We found that sore throat was reported significantly more commonly by cases of Omicron compared to those with Delta. This is consistent with another study of PCR-positive cases in England [10]. However, the same study found sore throat was more commonly reported in symptomatic PCR-negative cases during December, suggesting that sore throat may not be a specific predictor of SARS-CoV-2 infection with Omicron. Common symptoms reported for SARS-CoV-2 are also caused by infection with other respiratory viruses that circulate in the UK (influenza A and B, respiratory syncytial virus, adenovirus, parainfluenza, rhinovirus and human metapneumovirus [15]). As we were unable to adjust for the potential impact of co-infections with these viruses, and as our dataset did not include PCR-negative cases, it is not possible to conclude that sore throat is a specific indicator of Omicron infection and further studies are required. An additional limitation to our study is that symptom data were collected at the time of contact tracing only, around 3–4 days post symptom onset, and additional, later-presenting symptoms could not be captured. Symptoms were also self-reported and subject to bias.
Loss of smell and taste was another symptom highlighted in our study. Individuals with Delta infections were significantly more likely to experience this symptom than individuals infected with the Omicron variant. This was also observed in the University of Oxford and Office for National Statistics studies [10], where loss of smell and taste was reported more frequently for wild-type and Delta variant cases compared to Alpha variant cases. Recent studies using animal models have shown the reduced presence of the Omicron variant in lung and nasal tissue in comparison to the original SARS-CoV-2 virus [16–18]. Indeed, when comparing the relative pathogenesis and viral loads of both variants, viral loads were significantly lower in both lung and nasal tissue extracted from mice [16]. Reduced Omicron replication in the nasal tissue may explain why some symptoms, such as loss of smell, are not as pronounced in Omicron infections.

This study describes the changes in reported symptoms associated with the Omicron variant in England. We found sore throat was more common, and loss of smell or taste less common, among people with an Omicron infection compared to a Delta infection. However, all symptoms were found to be reported in cases for both variants, suggesting that testing should remain widespread for many symptoms. Nearly 40% of people with Omicron did not have one of the three key symptoms still used as likely clinical indicators of COVID-19: ensuring professional and public awareness of the variety of SARS-CoV-2 symptoms is needed to ensure appropriate testing and diagnosis. Headache, sore throat and runny nose were the most frequently reported symptoms for Omicron: these non-specific symptoms are likely to be difficult to use to guide testing. As our cohort included only confirmed cases, further analysis including individuals testing negative is needed. Additionally, despite clear findings that indicate distinct symptom profiles for the two variants included in this analysis, our relatively simple modelling approach was not able to adequately discriminate between variants. Future work may be able to develop accurate (and more sophisticated) prediction models that could aid in the surveillance of variants in the absence of high coverage genomics.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0950268822001297

Acknowledgements. We thank the UK Health Security Agency’s Contact Tracing Data Management team for their input and discussions surrounding this project, especially Christopher Rawlinson, Tina Sorensen and Cong Chen for their advice and guidance on data analysis.

Financial support. No additional funding was required for this study. Authors are UK Health Security Agency staff.

Conflict of interest. None.

Ethical standards. This study was conducted as part of a public health response and ethical or regulatory approval was not required. Data were handled in accordance with UKHSA’s Research Ethics Committee’s regulatory requirements (Research Ethics and Government Group). UKHSA has legal permission, provided by Regulation 3 of The Health Service (Control of Patient Information) Regulations 2002 to collect confidential patient information under Sections 3(i) (a) to (c), 3(3) (d) (i) and (ii) and 3(3) as part of its outbreak response activities. Thus, this study fell outside the remit for ethical review. Permission to access and link to NIMS data was required and approved through a UKHSA Data Lake Internal Access Agreement according to institutional government policies. 

Case identification information was removed upon linkage between data sources to uphold with data protection policy.

Data availability statement. The data that support these studies were collected as part of a public health response, are considered sensitive and not made publicly available. Reasonable requests for access to anonymised data will be considered by the authors on request.

References

1. Rambaut A et al. (2020) Preliminary genomic characterisation of an emergent SARS-CoV-2 lineage in the UK defined by a novel set of spike mutations. Available at: https://virological.org/t/preliminary-genomic-characterisation-of-an-emergent-sars-cov-2-lineage-in-the-uk-defined-by-a-novel-set-of-spike-mutations/563 (Accessed 18 March 2022).
2. Davies NG et al. (2021) Estimated transmissibility and impact of SARS-CoV-2 lineage B.1.1.7 in England. Science 372, eabc3055.
3. Scientific Pandemic Influenza Group on Modelling: Consensus Statement on COVID-19. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/993321/S1267_SPI-M-O_Consensus_Statement.pdf (Accessed 14 February 2022).
4. UKHSA (2022) SARS-CoV-2 variants of concern and variants under investigation in England. Technical Briefing 34. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050236/technical-briefing-34-14-january-2022.pdf (Accessed 18 March 2022).
5. Menni C et al. (2020) Real-time tracking of self-reported symptoms to predict potential COVID-19. Nature Medicine 26, 1037–1040.
6. Pierron D et al. (2020) Smell and taste changes are early indicators of the COVID-19 pandemic and political decision effectiveness. Nature Communications 11, 5152.
7. Vihta K-D et al. (2021) Symptoms and SARS-CoV-2 positivity in the general population in the UK. medRxiv. doi: 2021.2008.2019.2126233
8. ZOE: Omicron and cold-like symptoms rapidly taking over in London. Available at https://covid.joinzoe.com/post/omicron-and-cold-like-symptoms-rapidly-taking-over-in-london (Accessed 18 January 2022).
9. ZOE: What are the new top 5 COVID symptoms? Available at https://covid.joinzoe.com/post/new-top-5-covid-symptoms (Accessed 18 January 2022).
10. Vihta K-D et al. (2022) Omicron-associated changes in SARS-CoV-2 symptoms in the United Kingdom. medRxiv. doi: 2022.2001.2018.22269082
11. Tessier E et al. Monitoring the COVID-19 immunisation programme through a National Immunisation Management System – England’s experience. medRxiv. doi: 2021.2021.2009.2014.21263578
12. COVID-19 vaccine surveillance report. Available at https://www.gov.uk/government/publications/covid-19-vaccine-weekly-surveillance-reports (Accessed 18 March 2022).
13. Abdulkhai SA et al. (2021) COVID-19 symptoms at hospital admission vary with age and sex: results from the ISARIC prospective multinational observational study. Infection 49, 889–905.
14. Larsen JR et al. (2020) Modeling the onset of symptoms of COVID-19. Frontiers in Public Health 8, 473. doi: 10.3389/fpubh.2020.00473.
15. UKHSA (2022) Weekly national Influenza and COVID-19 surveillance report. Week 2 report (up to week 1 data). 13 January 2022. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1046284/weekly-flu-and-covid-19-report-week-2-2022.pdf. (Accessed 18 March 2022).
16. Bentley EG et al. (2021) SARS-CoV-2 Omicron-B.1.1.529 variant leads to less severe disease than Pango B and Delta variants strains in a mouse model of severe COVID-19. bioRxiv. doi: 2021.2012.2026.474085
17. Hui KPY et al. (2022) SARS-CoV-2 Omicron variant replication in human bronchus and lung ex vivo. Nature 568(7902), 715–720.
18. Abdelnabi R et al. (2021) The omicron (B.1.1.529) SARS-CoV-2 variant of concern does not readily infect Syrian hamsters. bioRxiv. doi: 2021.2012.2024.474086