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Short communication

The epidemiology of infectious diseases in Europe in 2020 versus 2017–2019 and the rise of tick-borne encephalitis (1995–2020)

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ABSTRACT

Health control measures instituted in 2020 to mitigate the COVID-19 pandemic decreased the case numbers of many infectious diseases across Europe. One notable exception was tick-borne encephalitis (TBE). In Austria, Germany, Switzerland, Lithuania, and the Czech Republic, the upturn was significantly higher compared to the average of the three years previously ($P < 0.05$), with increases of 88%, 48%, 51%, 28%, and 18%, respectively. Six countries reported TBE incidences of $\geq 5$ cases/100,000, defined as highly endemic by the World Health Organization (WHO). Possible factors contributing to this surge may include increased participation in outdoor activities in endemic regions and increased tick counts/tick activity. In highly endemic regions, the WHO recommends that vaccination be offered to all age groups, including children.

1. Introduction

The emergence in December 2019 of the new coronavirus SARS-CoV-2, the causative agent of COVID-19, quickly swept around the globe, and on 11th March 2020 the World Health Organization (WHO) declared the COVID-19 pandemic (WHO, 2020). Consequently, parts of Europe put in place public health policies to contain the spread of the virus. Recent reports from Switzerland (Steffen et al., 2020) and Germany (Ulrich et al., 2021) documented substantial reductions in almost all recorded infectious diseases in 2020 as compared to earlier years. In these countries, one of the only infectious diseases to see an increase during this period was tick-borne encephalitis (TBE) (Steffen et al., 2020; Ulrich et al., 2021). In this report, we used data from the health departments of various European countries to investigate the prevalence of select infectious diseases under surveillance during 2020, and further explored the trend in TBE cases from 1995 through 2020.

2. Materials and methods

Data were sourced from the websites of health departments of the countries listed in Table 1. For the calculation of disease incidences per country, population denominator data were obtained from the Statistical Office of the EU (Eurostat) https://appsso.eurostat.ec.europa.eu (data extracted on 10 December 2021). The reported incidences for the year 2020 and the mean for the combined years 2017, 2018, and 2019 were compared using a chi-square test, with no adjustment made for multiple comparisons.

3. Results

3.1. Cases of TBE in select European countries (January 2020-December 2020)

The number of cases of TBE were found to have increased in 2020 compared to the average of the three years previously in thirteen select European countries: Austria, Germany, Switzerland, Finland, Norway, Lithuania, and the Czech Republic (Table 2) as well as in Slovakia, Slovenia, Belgium, Denmark, the United Kingdom and the Netherlands (Table 3). In five countries, the increases were significantly ($P < 0.05$) higher — Austria (88%), Germany (48%), Switzerland (51%), Lithuania (28%) and the Czech Republic (18%). Significant ($P < 0.05$) decreases in TBE were found in Poland (−36%) and Sweden (−27%).

3.2. Case numbers and incidence of TBE (1995–2020)

The year 2020 saw the highest ever number of TBE cases since 1995
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decreased in 2020 compared to the average of the three years previously 
diseases, including airborne diseases such as

3.3. Trends in other infectious diseases in twelve European countries

for eight countries (Austria, Switzerland, Germany, Slovakia, Finland, NORWAY, BELGIUM, and the NETHERLANDS) (Table 3). The highest notification rates of TBE in 2020 occurred in LITHUANIA, LATVIA, SLOVEnIA, and the CZECH REPUBLIC, with incidences of 23.94, 11.01, 8.92, and 7.99 cases/100,000 population, respectively (Table 3 and Fig. 1). These four countries as well as ESTONIA (incidence of 5.12) and SWITZERLAND (incidence of 5.31) reported incidences of ≥5 per 100,000/year. Incidences of TBE per country per 100,000 inhabitants in 2020 is shown in Fig. 1.

3.3. Trends in other infectious diseases in twelve European countries (2017 – 2020)

with few exceptions, the number of cases of a range of infectious diseases, including airborne diseases such as Haemophilus influenzae, Meningococcal disease, and Streptococcus pneumoniae, were significantly decreased in 2020 compared to the average of the three years previously (Table 2). The largest and most consistent decrease was seen in rotavirus, where seven (GERMANY, FINLAND, ESTONIA, LATVIA, LITHUANIA, HUNGARY, and POLAND) of eight countries reporting on rotavirus recorded reductions of 53–93%. Other than TBE, pertussis, influenza, gonorrhea, and chlamydia were the only other infectious diseases to have seen significant (P<0.05) increases in 2020 vs. the mean of the three previous years, and only in select countries. Influenza increased by 4% in GERMANY, gonorrhea by 11% in SWITZERLAND, chlamydia by 7% in FINLAND, and pertussis by 176% in LITHUANIA.

4. Discussion

Over a 25-year period from 1995 to 2020, the number of cases of TBE across many European countries has trended upwards. Specifically comparing 2020 to the mean number of cases of 2017–2019, countries in the alpine regions demonstrated significant increases of 48–88% in TBE, with record number of cases reported in SWITZERLAND and GERMANY. Other countries that saw a significant increase in TBE cases during this period were the CZECH REPUBLIC (18%) and LITHUANIA (28%). In contrast, the changes in total TBE cases in other Northern and Eastern European countries were non-significant when compared to data from 2017-2019, with the exception of SWEDEN and POLAND where a significant decrease in cases was reported.

Other notifiable diseases, including airborne diseases such as Haemophilus influenzae, Meningococcal disease, and Streptococcus pneumoniae, were decreased in 2020 in Europe and other countries (Steffen

Table 1
Source Data.

| Country | Data source | Web Addresses |
|---------|-------------|---------------|
| England | Robert Koch Institute: Infection epidemiological yearbook | https://www.rki.de/DE/Content/Infekt/Jahrbuch/jahrbuch_node.html |
| Germany | State Public Health and Medical Officer Service: annual reports, data on infectious diseases | https://www.amts.hv.de/foels mentioning/Jarvany/Fertozo_betegsegk/Fertozo_eves_jelentesek & https://www.oek.hv/oeo.web/to=2561&nid=1308&pid=1&lang=hu |
| Austria | National Institute for Health and Welfare: Communicable Diseases Notification System (MSIS), NIPH | https://www.epidemiologijagjas-biletjeni.html |
| Slovakia | National Institute for Public Health: Department of epidemiology and surveillance of infectious diseases | http://wwwold.pbc.gov.pl/oldpage/epimindex/index_a.html |
| Slovenia | National Institute of Public Health: Health Statistical Yearbook of Slovenia | https://www.njiz.si/sl/njiz/revije/zzdravstveni-statistici-letovislovenje |
| Sweden | The Public Health Authority (Fohm): Statistics on infectious diseases | https://www.folkhalsomyndigheten.se/folkhalsorapportering-statistik/statistik-a-o/sjukdomstatistik/?letter=ABC#listing |
| United Kingdom | Gov.uk Tick-borne encephalitis: epidemiology, diagnosis and prevention | https://www.gov.uk/guidance/tick-borne-encephalitis-epidemiology-diagnosis-and-prevention |
| Switzerland | Federal Office of Public Health FOPH: BAG-Bulletin | https://www.bag.admin.ch/bag/de/home/das-bag/publikationen/periodika/bag-bulletin.html |

Web links last accessed July 2021.
Table 2
Number of cases of notifiable infectious diseases in European countries (2017 – 2020).

| Infectious disease | AUSTRIA | GERMANY | SWITZERLAND | P value |
|--------------------|---------|---------|-------------|---------|
| Pertussis          | 1411    | 2202    | 2233        | 0.0001  |
| Haemophilus        | 39      | 49      | 64          | 0.0001  |
| influenae          |         |         |             |         |
| Meningococcal      | 20      | 30      | 24          | 0.0001  |
| disease            |         |         |             |         |
| Streptococcus      | 545     | 611     | 615         | 0.0001  |
| pneumoniae         |         |         |             |         |
| Tuberculosis       | 570     | 480     | 474         | 0.0001  |
| Norovirus          | 1173    | 1572    | 1900        | 0.0001  |
| Rotavirus          | 203     | 181     | 184         | 0.0001  |
| Hepatitis A        | 242     | 80      | 76          | 0.0001  |
| HIV                | 3144    | 2818    | 3093        | 0.0001  |
| Gonorrhoea         | 123     | 171     | 106         | 0.0001  |
| Chlamydia          |         |         |             |         |
| TBE (tick-borne    | 822     | 761     | 748         | 0.0001  |
| encephalitis)      |         |         |             |         |

| Infectious disease | FINLAND | NORWAY | SWEDEN | P value |
|--------------------|---------|--------|--------|---------|
| Pertussis          | 10      | 15     | 12     | 0.0001  |
| Haemophilus        | 269     | 359    | 206    | 0.0001  |
| influenae          |         |        |        |         |
| Meningococcal      | 16      | 16     | 16     | 0.0001  |
| disease            |         |        |        |         |
| Streptococcus      | 822     | 761    | 748    | 0.0001  |
| pneumoniae         |         |        |        |         |
| Tuberculosis       | 10      | 15     | 12     | 0.0001  |
| Norovirus          | 3874    | 2336   | 3392   | 0.0001  |
| Rotavirus          | 269     | 359    | 206    | 0.0001  |
| Hepatitis A        | 29      | 28     | 18     | 0.0001  |
| HIV                | 159     | 151    | 149    | 0.0001  |
| Gonorrhoea         | 604     | 501    | 607    | 0.0001  |
| Chlamydia          | 14,535  | 14,911 | 16,179 | 0.0001  |
| TBE (tick-borne    | 85      | 79     | 69     | 0.0001  |
| encephalitis)      |         |        |        |         |

(continued on next page)
## Table 2 (continued)

| infectious disease          | ESTONIA 2017 | ESTONIA 2018 | ESTONIA 2019 | ESTONIA 2020 | Mean 2017–19 | % change 2017 vs Mean | P value 2017–19 | LATVIA 2017 | LATVIA 2018 | LATVIA 2019 | LATVIA 2020 | Mean 2017–19 | % change 2020 vs Mean | P value 2017–19 | LITHUANIA 2017 | LITHUANIA 2018 | LITHUANIA 2019 | LITHUANIA 2020 | Mean 2017–19 | % change 2020 vs Mean | P value 2017–19 |
|-----------------------------|--------------|--------------|--------------|--------------|---------------|---------------------|-----------------|-------------|-------------|-------------|-------------|---------------|---------------------|-----------------|----------------|----------------|----------------|----------------|---------------|---------------------|-----------------|
| Influenza                   | 7408         | 14,300       | 14,668       | 11,498       | 11,125        | −62                | <0.0001         | 0.0002      | 95          | 159         | 720         | 342            | 325                | 5                | 0.3995       | 21           | 27           | 26          | 68          | 25            | 176                | <0.0001         |
| Pertussis                   | 56           | 69           | 135          | 44           | 87            | −49                | −0.0001         | −0.0002      | 1450        | 1342        | 1432        | 256            | 1459               | −82               | <0.0001       | 3061         | 1548         | 1629        | 743         | 7           | 818          | −99                | <0.0001         |
| Haemophilus influenzae      | 53           | 75           | 69           | 36           | 66            | −45                | 0.0027          | 210         | 128         | 178         | 259         | 257            | 319                | −19               | 0.0158       | 108          | 115          | 9           | 70          | 36           | 115        | <0.0001       |
| Meningococcal disease       | 4            | 9            | 4            | 4            | 6             | −29                | 0.5213          | 32          | 37          | 31          | 112         | 81             | 3951               | −31               | 0.4551       | 81           | 40           | 37          | 12          | 53           | −77                | <0.0001         |
| Streptococcus pneumoniae    | 160          | 195          | 220          | 82           | 192           | −57                | <0.0001         | 0.2151      | 214         | 169         | 250         | 210            | 211                | 0                 | 0.9223       | 474          | 384          | 711         | 669         | 523           | 28                | <0.0001         |

### Notes

- P-value derived from the comparison of reported incidences for 2020 vs the mean of years 2017, 2018 and 2019 using a chi-square test, with no adjustment made for multiple comparisons.

### Additional Information

- TBE (tick-borne encephalitis)
| Country        | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Mean  | 2020incidence |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Austria       | 109  | 128  | 99   | 62   | 41   | 60   | 54   | 60   | 82   | 54   | 100  | 84   | 45   | 86   | 79   | 63   | 103  | 49   | 100  | 81   | 79   | 95   | 123  | 171  | 250  | 133  | 2.81 |
| Belgium*      | 2    | 0    | 3    | 1    | 0.03 |
| Czech         | 744  | 571  | 415  | 422  | 490  | 719  | 633  | 647  | 606  | 507  | 643  | 1029 | 546  | 631  | 816  | 589  | 861  | 573  | 625  | 410  | 355  | 565  | 687  | 715  | 774  | 854  | 725  | 7.99 |
| Denmark*      | 175  | 177  | 404  | 387  | 185  | 272  | 215  | 90   | 237  | 182  | 164  | 171  | 140  | 90   | 179  | 201  | 250  | 178  | 114  | 83   | 116  | 81   | 87   | 85   | 83   | 68   | 85   | 5.12 |
| Finland       | 5    | 8    | 19   | 16   | 12   | 42   | 33   | 38   | 16   | 29   | 16   | 18   | 20   | 23   | 25   | 38   | 43   | 39   | 38   | 47   | 68   | 61   | 85   | 79   | 69   | 92   | 78   | 1.67 |
| Germany       | 226  | 114  | 211  | 148  | 115  | 133  | 225  | 239  | 278  | 274  | 431  | 547  | 238  | 285  | 313  | 260  | 422  | 195  | 420  | 265  | 223  | 348  | 485  | 583  | 445  | 748  | 504  | 0.90 |
| Estonia       | 234  | 224  | 99   | 84   | 51   | 45   | 76   | 80   | 114  | 89   | 52   | 56   | 62   | 70   | 64   | 50   | 43   | 44   | 53   | 31   | 24   | 19   | 16   | 32   | 18   | 18   | 22   | 0.18 |
| Latvia        | 6    | 8    | 8    | 11   | 5    | 15   | 19   | 6    | 14   | 23   | 22   | 14   | 4    | 34   | 32   | 21   | 26   | 34   | 42   | 22   | 14   | 53   | 24   | 39   | 24   | 21   | 29   | 0.04 |
| Lithuania     | 426  | 309  | 645  | 548  | 171  | 419  | 298  | 168  | 763  | 425  | 423  | 462  | 234  | 220  | 617  | 612  | 365  | 495  | 501  | 353  | 336  | 633  | 474  | 384  | 711  | 669  | 523  | 23.94 |
| Luxembourg    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0.00 |
| Netherlands*  | 1    | 1    | 1    | 0    | 2    | 1    | 2    | 3    | 3    | 13   | 9    | 10   | 11   | 14   | 7    | 6    | 13   | 9    | 12   | 16   | 26   | 35   | 41   | 26   | 11.01 |
| Norway        | 1    | 1    | 1    | 0    | 2    | 1    | 2    | 3    | 3    | 13   | 9    | 10   | 11   | 14   | 7    | 6    | 13   | 9    | 12   | 16   | 26   | 35   | 41   | 26   | 0.76 |
| Portugal      | 267  | 257  | 201  | 208  | 101  | 170  | 210  | 126  | 339  | 262  | 177  | 317  | 233  | 202  | 351  | 294  | 221  | 189  | 227  | 195  | 149  | 283  | 283  | 197  | 265  | 158  | 248  | 0.42 |
| Slovakia      | 89   | 82   | 76   | 54   | 63   | 92   | 75   | 62   | 74   | 70   | 50   | 91   | 57   | 79   | 76   | 90   | 108  | 107  | 162  | 117  | 88   | 174  | 75   | 156  | 161  | 176  | 131  | 3.22 |
| Slovene       | 260  | 406  | 274  | 136  | 150  | 190  | 260  | 262  | 282  | 204  | 297  | 373  | 199  | 246  | 307  | 166  | 247  | 164  | 309  | 100  | 62   | 83   | 102  | 153  | 87   | 187  | 114  | 8.92 |
| Sweden        | 68   | 44   | 76   | 64   | 53   | 133  | 128  | 105  | 105  | 174  | 138  | 163  | 185  | 224  | 210  | 174  | 284  | 287  | 209  | 178  | 268  | 238  | 391  | 385  | 358  | 275  | 378  | 2.66 |
| United Kingdom*| 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0.00 |
| Switzerland   | 60   | 62   | 123  | 68   | 112  | 91   | 107  | 53   | 116  | 138  | 206  | 259  | 113  | 127  | 118  | 90   | 175  | 95   | 205  | 113  | 121  | 206  | 269  | 375  | 375  | 457  | 302  | 5.31 |

* suspected autochthonous cases only
The reduction in these infections may be linked to mitigation efforts (including social distancing, school closures, travel restrictions, and mask wearing, and an emphasis on hand washing) put in place to prevent the spread of COVID-19 (Steffen et al., 2020; Sullivan et al., 2020; Ulrich et al., 2021). Furthermore, day-care closures were likely responsible for the consistently large decline in rotavirus, as interactions between infants and young children were reduced. A potential explanation for the rise in pertussis in Lithuania could be increased health seeking behaviours and subsequent pertussis diagnosis.

TBE, an infectious disease of the central nervous system caused by the tick-borne encephalitis virus (TBEV), is endemic in Eastern, Central, and Northern Europe as well as in northern China, Japan, Mongolia, and the Russian Federation (World Health Organization, 2011). Transmission usually occurs via the bite of an infected tick. Infrequently, though, humans also can be infected by consuming unpasteurised dairy products (Brockmann et al., 2018; Kohlmaier et al., 2021).

Factors driving TBE incidence can be classified into three areas: (i) tick abundance, (ii) population at risk, and (iii) surveillance characteristics (Martin et al., 2020; Ociás et al., 2019; Ulrich et al., 2021; World Health Organization, 2011). Tick abundance is related to environmental conditions, including land use, weather, host reservoirs, and climate change, and can be very focal (Süss et al., 2008). An earlier occurrence of spring can accelerate tick development (Jaenson et al., 2012). Additionally, milder winters permit winter activity of ticks and may increase population of hosts to sustain greater tick populations (Süss et al., 2008). The weather conditions in Switzerland during winter months of late 2019/early 2020 were suitable to meet these conditions and may explain the high number of TBE cases in 2020. Indeed, the national average winter temperature rose to 0.7°C (MeteoSchweiz, 2020). Unusually high winter temperatures, with a national average over 0°C, have occurred only four times in Switzerland since 1864, when temperature record-keeping began (MeteoSchweiz, 2020). Complementing this was the arrival of a very early spring 2020, as classified by the spring index (Federal Office of Meteorology and Climatology MeteoSwiss, 2021).

Changes in human behaviour (e.g., increase of at-risk outdoor recreational activities) can put people at greater risk of exposure to ticks and thus TBE. This is one factor that may have contributed to the increase of TBE during the COVID-19 lockdown, as shown by the actual versus predicted numbers in Austria and Germany. The predicted number of TBE cases for 2020 based on negative binomial regression models ranged from 142 to 156 for Austria (vs 250 actual), 663–670 for Germany (actual 748), and 465–472 for Switzerland (actual 457) (Rubel and Brugger, 2020, 2021). Interestingly, a 225% increase in visitor frequency to public green spaces, including national parks and public gardens, was reported in the Google Mobility Report of May 2020 for Germany (Schweizer et al., 2021).

Underreporting to surveillance systems in 2020 may have been a factor in some countries where there was a decrease in TBE. One analysis from Poland suggested that access to specialised diagnostic testing for TBE may have been limited during the pandemic due to overburdened healthcare resources (Sulik et al., 2021).

A limitation of this study is that mandatory reporting of infectious diseases varied across countries; as such, the data found on the websites of health departments were not uniformly available for all countries. In addition, changes in health care seeking behaviours and the number of laboratory tests conducted during the pandemic may have altered compared to the previous years, and these factors may have led to reporting bias for 2020 (Simões et al., 2020).

5. Conclusions

The overall trend in number of TBE cases across Europe is on an upward trajectory, although with regional and temporal variations. Several factors may be involved, including global warming and social behaviours. Long-lasting morbidity from TBE, limiting function and quality of life, are seen in up to 30% of those hospitalised with TBE (Bogovic et al., 2018; Kohlmaier et al., 2021). With no curative treatment available, vaccination remains the most effective method to prevent infection, with reported effectiveness rates of 95–99% (Heinz et al., 2013; Erber et al., 2022). The WHO recommends TBE vaccination for adults and children in highly endemic (≥5 cases/100,000 population/year) areas and targeted vaccination in specific geographical locations or when participating in at-risk outdoor activities (World Health Organization, 2011). Compliance with TBE vaccination is low in many
European countries (Erber and Schmitt, 2018). Thus, increasing awareness and education regarding vaccination against TBE for those travelling to or residing in endemic areas are critical interventions for addressing this growing public health issue.

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**Declaration of Competing Interest**

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