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13 **Impact of the COVID-19 pandemic on the circulation of other pathogens**
14 **in England**

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21

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31 All data are provided in the manuscript and its supplements.

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35 **Conflict of interest disclosure**

36 Nothing to declare.

37 **Author contributions**

38 L.H. and M.M. developed the project idea. L.H. and H.U. performed the
39 research. M.N.W. and M.M. supervised the research. All authors analysed data. M.M.
40 wrote the initial manuscript draft. All authors contributed to the finalisation of the
41 manuscript. All authors approved the final version of the manuscript.

42 **Ethics approval statement**

43 Not applicable.

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49 Not applicable.

50

51 Dear Editor,

52 Previous studies suggested that non-pharmaceutical interventions during the
53 COVID-19 pandemic have also affected the spread of other pathogens [1-4]. Here, we
54 analysed the transmission patterns of 22 infectious diseases in England in the context
55 of the COVID-19 prevention measures, using data derived from the UK Health Security
56 Agency, the UK Office for National Statistics, and the Royal College of General
57 Practitioners Research and Surveillance Centre (Suppl. Methods, Suppl. Table 1,
58 Suppl. Table 2).

59 Reported cases for all investigated infectious diseases dipped in response to
60 the first lockdown except from methicillin-resistant *Staphylococcus aureus* (MRSA),
61 Lyme disease, and hepatitis E (Figure 1, Suppl. Figures 1-22). MRSA infections are
62 usually diagnosed in healthcare settings [5], and some studies reported an increase
63 of MRSA cases during COVID-19 [5]. Hepatitis E is predominantly transmitted by
64 contaminated food in England, in particular from farmed pigs [6]. Therefore, these
65 findings do not seem to be surprising.

66 Lyme disease was not reduced during the initial lockdown but a decrease has
67 been reported later in the pandemic (Figure 1, Suppl. Figure 22), which is probably
68 attributed to underreporting [7,8]. Generally, the drop in documented cases during the
69 first lockdown is difficult to interpret, as it might be the consequence of underreporting
70 [7-9].

71 Thirteen diseases displayed a sustained reduction when prevention measures
72 were in place (Figure 1, Suppl. Figures 1-22), including nine of the ten diseases that
73 spread via the air and four of the six diseases characterised by faecal-oral
74 transmission (Figure 1, Suppl. Figures 1-10 and 16-21).

75

76 The prevention measure-associated associated reduction of airborne
77 pathogens confirms other findings [3,10]. The only exception was tuberculosis (Figure
78 1, Suppl. Figure 9). Most tuberculosis infections are asymptomatic and go
79 undiagnosed [11,12]. Delayed diagnoses due to limited access to tuberculosis
80 services during the pandemic may have caused a rise of severe cases, including
81 COVID-19/ tuberculosis co-infections [12,13]. Hence, the pandemic measures may
82 not have reduced severe tuberculosis cases, which are typically diagnosed.

83 Moreover, our findings agree with others showing that hygiene measures and
84 physical distancing reduce the transmission of enteric diseases that are transmitted
85 via the faecal-oral route [3,9,10,14,15]. Exceptions may indicate pathogens that are
86 predominantly spread by food contaminations without significant further human-to-
87 human transmission [6]. Also in agreement with previous findings [3], the pandemic-
88 related prevention measures disrupted the seasonal transmission patterns of different
89 infectious diseases (Figure 1; Suppl. Figures 1,2,6,7,20).

90 There are concerns that the disruption of routine vaccinations may affect
91 population immunity resulting in larger outbreaks of vaccine-preventable diseases [3].
92 However, our findings indicate a sustainable suppression of vaccine-preventable
93 diseases also beyond the lifting of restrictions (Figure 1). This included measles,
94 mumps, rubella, pertussis, and pneumococcal disease (Suppl. Figures 3-6,10).
95 Although our data also indicate a sustained reduction of influenza-like illnesses, other
96 data suggest that influenza cases should be expected to rebound [16,17]. This may
97 reflect the relatively low influenza vaccination rates and influenza vaccine efficacy
98 compared to other vaccine-preventable diseases [18].

99 By contrast, non-vaccine preventable respiratory infections including
100 chickenpox (not part of routine vaccinations in the UK), scarlet fever, and streptococcal

101 pharyngitis displayed an immediate resurgence after the removal of prevention
102 measures (Suppl. Figures 1,7,8), suggesting that similar transmission peaks have
103 been prevented by the vaccine-mediated immunity for the diseases with high vaccine
104 coverage in the UK.

105 Concerns have been raised that a lack of exposure to common pathogens may
106 result in decreased immunity enabling larger and more deleterious outbreaks [3].
107 However, only four infectious diseases (chickenpox, herpes simplex virus, Skin and
108 Subcutaneous Tissue Infections, Infectious Intestinal Diseases) have since the
109 removal of all restrictions in England on 19th July 2021 resulted in higher spread levels
110 than pre-COVID-19 (Figure 1). It remains to be investigated whether these increases
111 may be related to COVID-19.

112 In conclusion, our analysis shows that the COVID-19 prevention measures
113 reduced the spread of pathogens that are transmitted via the air and the faecal-oral
114 route. Despite concerns that a lack of exposure to common pathogens may affect
115 population immunity and result in large outbreaks by various pathogens post-COVID-
116 19, only four of the 22 investigated diseases and disease groups displayed higher
117 post- than pre-pandemic levels without an obvious causative relationship. This
118 included chickenpox for which an effective vaccine is available [19] but not used in the
119 UK. Notably, the COVID-19 prevention measures resulted in the sustained
120 suppression of vaccine-preventable infectious diseases also after the removal of
121 restrictions, while non-vaccine preventable diseases displayed a rapid rebound,
122 supporting the importance of effective vaccination programmes. More research
123 investigating how disease burden can be reduced by tolerable non-pharmaceutical
124 interventions is warranted.

125

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- 188
- 189

190 **Figure legend**

191

192 **Figure 1. Impact of COVID-19 prevention measures on the circulation of other**
193 **infectious diseases.** Overview table providing a qualitative description of the impact
194 of the COVID-19 measures on the investigated pathogens in England and curves
195 illustrating the impact of the COVID-19 measures on hepatitis C, measles, and
196 chickenpox. Detailed information is presented in the Suppl. Figures 1-22.

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