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SHORT COMMUNICATION

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Respiratory virus circulation in children after relaxation of COVID-19 restrictions in fall 2021—A nationwide register study in Finland

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Abstract

Social restrictions interrupted the normal respiratory virus circulation in Spring 2020. This report describes virus circulation in the pediatric population before and after the restrictions ended in Finland in September 2021. We used data from the Finnish Infectious Disease Register. Nationwide influenza A and B, rhinovirus, severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2), and respiratory syncytial virus (RSV) findings from January 2018 to December 2021. Age stratified (0–4, 5–9, and 10–14 years) weekly incidences per 100 000 children were calculated. School and day-care closures interrupted completely the circulation of all other respiratory viruses than rhinovirus in spring 2020. After restrictions were relaxed in September 2021, SARS-Cov-2 detections increased majorly. We observed high RSV season atypically early. SARS-Cov-2 was detected in older children whereas RSV season peaked especially among children aged under 5. Influenza seemed to return to normal circulation. In conclusion, we report that the ending of social restrictions in September 2021 led to an increase in SARS-Cov-2 detections and high epidemic peaks of RSV and parainfluenza in atypical timing in children. Our results highlight the importance of continuous pathogen surveillance during the pandemic, as atypical surges of non-COVID-19 respiratory viruses were observed.

KEYWORDS
adenovirus, COVID-19, influenza, parainfluenza, rhinovirus, RSV

1 | BACKGROUND

Typical respiratory viruses vanished as schools and daycare facilities were closed in March 2020 due to the COVID-19 pandemic in Finland.[1,2] Respiratory syncytial virus (RSV), influenza A + B, rhinovirus, parainfluenza, adenovirus, and enteroviruses all had a temporary decrease in circulation in Spring 2020.[3] Rhinoviruses were the first to continue spreading after the schools and daycares were opened in Finland in May 2020.[4] All children have attended schools and daycares normally without masks in Finland since August 2020. There were practically no restrictions set towards airborne transmission in schools and daycares as only hand hygiene measures were implemented. Sick children were ordered to be fully recovered and have a negative COVID-19 test before returning to school or daycare. A complete list of the restrictions in Finland is in the appendix. These guidelines with

traveling restrictions prevented Influenza and RSV completely in Winter 2020–2021 as there were less than 10 cases of each.[5,6] Finland differed from many countries, as RSV cases had a resurgence after the restrictions were relaxed for example in Australia, France, Israel, Japan, South Korea, Thailand, and the USA.[7–11]

The main circulating severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2) variant was the original strain until early 2021 when first alpha and then beta variants became dominating.[12] Those remained dominant until June 2021, when the delta variant came to Finland from football tourists returning home from Russia and UEFA Euro 2020.[13] Delta remained as the main variant until December 2021, when omicron took the dominant role in 3 weeks.[14]

Finland decided to renovate the test, tract, and isolate strategy in August 2021. First children aged under 12 did not require COVID-19 testing if symptoms were mild. Children were eligible to return to school and daycare once symptoms showed signs of relief. In September 2021, all the implemented restrictions were lifted, and restaurants, bars, events, and gatherings had no more personal limitations. Mask mandate remained in use. These changes were made after the vaccination coverage among inhabitants aged 12 or more was over 80% for the first shot and over 60% for the second shot. A backlash occurred at the start of December 2021, when the Omicron variant arrived in Finland, but restrictions did not change. We already saw that the incidence of parainfluenza detections increased notably after the restrictions were ended in our previous report, as the epidemic peak in fall 2021 was seven times higher than any of the previous seasons and it came in atypical fall time instead of spring.[15]

The aim of this report is to present how the relaxation of restrictions affected the virus circulation of the most common respiratory pathogens in Finnish children during the fall of 2021.

2 | MATERIALS

Data for this retrospective register-based surveillance study were gathered from the National Infectious Disease Register, maintained by the Finnish Institute of Health and Welfare.[16] The register is an open-access surveillance system updated daily in which all laboratories are mandated by the law on contagious diseases to immediately report all findings on notifiable diseases. The reporting delay is minimal, and the register provides current information. The complete list of notifiable diseases can be found in the register description.[16]

For this study, all laboratory-confirmed polymerase chain reaction (PCR) positive findings of the five most common respiratory virus pathogens (SARS-Cov-2, influenza virus A and B, rhinovirus, and RSV) from January 2018 to December 2021 were included. The denominator used in the analyses was the entire Finnish pediatric population (age 0–14 years) of ca. 0.9 million. The age-stratified population information was gathered from the Finnish Population Center's open-access population statistics datasets. The positive virus findings are presented as weekly incidences per 100 000 children and stratified by age (0-4, 5-9, and 10-14 years). These viruses are part of the typical multiplex PCR respiratory panel, which is used in pediatric hospitals for testing and diagnosing acute respiratory illnesses. Additionally, influenza and RSV are tested in a primary care setting in the nasopharyngeal swab PCR panel. During the pandemic, all Finnish pediatric emergency departments utilized a combined rapid PCR panel which includes SARS-Cov-2, influenza A and B, and RSV. Due to the study's use of open-access public data, no research permissions or ethical evaluations were needed.

3 | RESULTS

3.1 | Severe acute respiratory syndrome coronavirus 2

We included a total of 57 924 PCR positive SARS-Cov-2 findings from March 2020 to December 2021. Of these, 10 651 (18.4%) were among 0–4 years, 23 145 (40.0%) among 5–9 years, and 24 128 (41.6%) among 10–14 years old. The epidemic peaks were relatively small in children in 2020 and early 2021 (Figure 1). The peaks occurred simultaneously in all age groups. The majority of the findings were detected in the fall of 2021 and the dominant variant was delta in Finland until Christmas 2021. The highest recorded weekly incidence (896 per 100 000) was in December 2021 among children aged 10–14 years.

3.2 | Influenza A

A total of 10 077 laboratory-confirmed cases of influenza A were included. Of these 4150 (41.2%) were among children aged 0–4 years, 3631 (36.0%) among 5–9 years, and 2296 (22.8%) among 10–14 years. The epidemic starts typically in December and

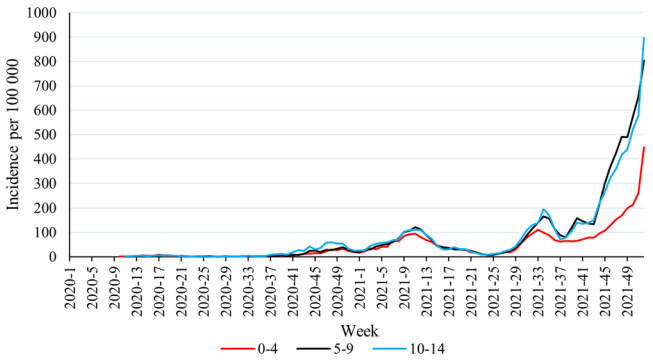

FIGURE 1 Weekly incidence of polymerase chain reaction-confirmed severe acute respiratory syndrome coronavirus 2 findings stratified by age (0–4, 5–9, and 10–14 years) in Finland from January 2020 to December 2021.

FIGURE 2 (A) Weekly incidences of influenza A findings stratified by age (0–4, 5–9, and 10–14 years) in Finland from January 2018 to December 2021. (B) Weekly incidences of influenza B findings were stratified by age (0–4, 5–9, and 10–14 years) in Finland from January 2018 to December 2021. (C) Weekly incidences of respiratory syncytial virus findings were stratified by age (0–4, 5–9, and 10–14 years) in Finland from January 2018 to December 2021. (D) Weekly incidences of rhinovirus findings were stratified by age (0–4, 5–9, and 10–14 years) in Finland from January 2018 to December 2021.

continues to late spring in Finland (Figure 2A). Influenza A detections went to 0 as the pandemic began in March 2021. Influenza A returned to circulation in Week 46 in Finland and the beginning of the season 2021–2022 seems like the season started in 2018–2019.

3.3 | Influenza B

We included 5181 laboratory-confirmed influenza B detections from January 2018 to December 2021. Of these 1445 (27.9%) were among children aged 0–4 years, 2178 (42.0%) among 5–9 years, and 1558 (30.1%) among 10–14 years. Influenza B epidemic begins typically in December and the epidemic peak is in February or March (Figure 2B). Influenza B circulation ended in March 2020 due to the restrictions and it was then not detected in Finland until Week 45 of 2021.

3.4 | Respiratory syncytial virus

We included 13 728 RSV detections and the highest burden was among children aged 0–4 years as 12 545 (91.4%) of the cases were reported in this age group. RSV follows a biennial cycle in Finland and the season 2019–2020 was a high incidence season that ended rapidly due to the restrictions in March 2020. The 2020–2021 season was expected to be a low incidence season, but it never appeared. As the restrictions were lifted in September 2021, RSV turned into an

immediate increase (Figure 2C). The RSV season 2021–2022 peaked already in December as the typical peak is in February.

3.5 | Rhinovirus

We found 2651 laboratory-confirmed cases of rhinovirus in the register. Of these 2191 (82.6%) were detected among 0–4 years old, 315 (11.9%) among 5–9 years old, and 145 (5.5) among children aged 10–14 years. Rhinovirus detections remained practically unchanged in all age groups throughout the pandemic period in Finland (Figure 2D).

4 | DISCUSSION

After the relaxation of social restrictions in September 2021, we observed major epidemic peaks of pediatric COVID-19, RSV, and parainfluenza infections in Finland. RSV peak occurred with atypically early timing as it has traditionally peaked in the spring. Rhinovirus spreading seemed to continue as usual throughout the pandemic. Influenza seemed to return to normal circulation after being undetected for 1–5 years.

It was not surprising that the incidence of SARS-Cov-2 findings started to increase in children in September 2021. The restrictions were relaxed due to the high vaccination rate in adults (75% had at least two doses) and children´s vaccinations had not started. During the initial waves, it seemed that children were less likely to catch and transmit SARS-Cov-2 than adults.[17,18] As the pandemic continued, new variants emerged, and vaccination coverage increased among the adults, also children started to get infected and transmit SARS-Cov-2.[19–21]

It was surprising that the RSV and influenza seasons did not appear at all in seasons 2020–2021 as schools and daycares were kept normally open. During Winter 2020–2021, travel restrictions were in place and masking mandate for adults in use and these may have contributed to preventing the seasons. As masking mandates have remained in use through 2021, traveling restrictions probably were more crucial. Traveling started to increase in the fall of 2021 and as all restrictions set towards adults were ended in September 2021, RSV and influenza seasons returned in Finland. A previous report from Japan described that the RSV season beginning was associated with the overseas traveling,[22] and during the 2009 influenza, pandemic traveling seemed to correlate with epidemic incidences and dynamics.[23] As both influenza and RSV have typical global hemispheric circulation it seems reasonable that traveling restrictions have influenced the epidemic dynamics and typical circulation. Traveling restrictions have not been equally effective against rhinoviruses as those have more endemic epidemic cycles as there are more than 150 recognized lineages circulating.[24]

We prepared for RSV surge in Finland as RSV resurgence with atypical timing was reported from all over the world after restrictions were relaxed[7–11] and therefore it was unsurprising that it initially came with atypical timing. Rhinovirus has continued to spread normally throughout the pandemic in Finland as also reported in many countries.[25–27] As mask mandating has remained practically unchanged since fall 2020 in Finland, it is unlikely that it has been the main contributor to the changing epidemiology of respiratory viruses in Finland.

Our main strength is the nationwide Infectious Disease Register, where all report the positive findings. Therefore, the coverage and accuracy of the register are extremely high. We have some limitations to our results. First, as we do not have the total number of tests taken, we cannot be completely sure, whether the observed changes would have been due to variations in testing. But the testing rates can be indirectly estimated from the rhinovirus detections and as these have remained practically unchanged throughout the pandemic, the testing remained most likely unchanged. Second is the lack of clinical data, as we do not know if the severity of the infections has differed during the pandemic compared to the prepandemic era.

5 | CONCLUSION

In conclusion, we report that the ending of social restrictions in September 2021 lead to an increase in SARS-Cov-2 detections and a high epidemic peak of RSV with atypical timing. It seems also that travel restrictions have been effective against the spreading of many pathogens that have typical global seasonal circulation. Our results highlight the importance of continuous respiratory pathogen surveillance during pandemics as atypically strong epidemics in atypical periods have emerged during the pandemic as restrictions have been changed.

AUTHOR CONTRIBUTIONS

Ilari Kuitunen and Marjo Renko had the original idea. Miia Artama gathered and provided the data. Ilari Kuitunen and Marjut Haapanen were in charge of statistical analyses. Marjo Renko supervised the project. Ilari Kuitunen wrote the initial draft. All authors participated in the revision process and have approved the final version to be submitted. All authors had full access to the data and take full responsibility for the integrity and reporting.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

All data used in this study are available upon request from the corresponding author.

ETHICS STATEMENT

Ethical committee approval was not obtained or needed according to the Finnish research laws due to the retrospective register-based study design.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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