Significant impact of nationwide SARS-CoV-2 lockdown measures on the circulation of other respiratory virus infections

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Short Report

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Abstract

Since the worldwide spread of SARS-CoV-2, different European countries reacted with temporarily nationwide lockdowns with the aim to limit the virus transmission in the population. Also Austria started a lockdown of public life in March. In this study we investigated whether the circulation of different respiratory virus infections in Austria, as assessed by using the established respiratory virus surveillance system, is affected by these measures as well and may reflect the success of the lockdown in limiting respiratory virus transmission.

Sentinel data obtained for influenza virus, respiratory syncytial virus, human metapneumovirus and rhinovirus cases were analyzed and compared between the season 2019/ 2020 and the five previous seasons.

We observed a rapid and statistically significant reduction of cumulative cases for all these viruses within short time after the lockdown in March 2020, compared to previous seasons (each $p<0.001$). Also, sentinel screening for SARS-CoV-2 infections was performed and a decrease of SARS-CoV-2 was seen after the lockdown. While for the seasonally occurring viruses as influenza, respiratory syncytial virus or human metapneumovirus the lockdown led to the end of the annual epidemics, a re-increase of rhinovirus infections was observed after liberalization of numerous lockdown measures.

Our data provide evidence that occurrence of different respiratory virus infections reflect not only the efficiency of lockdown measures taken against SARS-CoV-2 but also the effects of their release on respiratory transmission.

Introduction

The SARS-Coronavirus-2 (SARS-CoV-2) epidemics started in 2019 in Hubei, spread around the world and reached the pandemic status in March 2020. In Europe first SARS-CoV-2 infections were detected end of January [1] but spread in European countries started probably already in December 2019 according to recent retrospective studies [2]. As larger outbreaks followed in Europe [4], countries developed different strategies to combat the SARS-CoV-2 epidemics. Most European countries decided for a temporarily strict downregulation of public life. In Austria, a public lockdown was started at 16th of March, with the closure of public areas, including schools, universities, restaurants, or shops, with the exception of structurally important shops and enterprises. Furthermore the government gave strict order to keep physical distance, carry face masks in public indoor locations, and to frequently wash and/or disinfect hands. These measures were kept until April 14th, when the stepwise release of the lockdown started.

The aim of the present study was to assess the impact of these lockdown measures on the epidemic spread of other respiratory viruses such as Influenza viruses, Respiratory Syncytial Virus (RSV), human Metapneumovirus (hMPV) and Rhinoviruses (RHIV). Therefore, we analyzed retrospectively the number of influenza virus, RSV, hMPV and RHIV cases detected by the Austrian Influenza sentinel surveillance system between week 48/2019 to week 28/2020 and compared them to those identified during the equivalent period of the five previous seasons, starting from week 40/2014.

Materials And Methods

This study is a retrospective data analysis based on the data routinely obtained by the sentinel surveillance system for influenza viruses in Austria. This sentinel system was described previously [5]. Briefly, the annual influenza virus surveillance is based on sentinel physicians (general practitioners and pediatricians throughout Austria) collecting nasopharyngeal swabs from patients with influenza like illness as defined by the ECDC. The samples are analyzed by the National Influenza Center Austria, Centre of Virology, Medical University Vienna by realtime PCR for the different Influenza strains as previously described [5]. In addition, each year the nasopharyngeal swab samples from a defined subset of sentinel physicians from all over Austria were also tested for RSV, hMPV and RHIV by realtime-PCR as previously described [6-8]. For this study results from 25.491 sentinel samples obtained between 40/2014 and 28/2020 were retrospectively analyzed. Influenza test results were available for all 25.491 samples. For a subset of 4.544 samples additional test results for other respiratory viruses including RSV, hMPV and RHIV were available. Altogether 10.009 samples were positive for either Influenza (7.211), RSV (1.231), hMPV (239) or RHIV (1.265). Detailed information on the number of samples tested each year and the number of positive samples observed during the seasons 2014/15 to 2019/20 is shown in Table 1.

Ethics statement:

This study was conducted at the Centre of Virology of the Medical University of Vienna, the WHO NIC for Austria. It is a retrospective analysis of epidemiological data of fully anonymized material collected during the annual influenza surveillance within the frame of Austria's Sentinel Physician Surveillance Network. Therefore an informed consent could not be obtained. The study was performed according to the Declaration of Helsinki and its Amendments and the research protocol was approved in its current form by the ethics committee of the Medical University of Vienna (EK: 1339/2017).

Results

Epidemiological analyses:

In Austria comprehensive lockdown measures for prevention of further SARS-CoV-2 spread were adopted on March 16^{th} 2020 (calendar week 12). In Figure 1 the weekly numbers of influenza, RSV, hMPV and RHIV cases detected by the sentinel system are shown for the season 2019/20, before and after the lockdown. For all these respiratory viruses a significant decrease was observed within one week after the lockdown. To assess whether the development of cases of influenza viruses, RSV, hMPV and RHIV in 2019/20 was different to previous seasons, a comparative analysis between the respiratory virus circulation pattern of this and the previous 5 seasons was performed. The data of the respiratory infections over the years are presented in detail in Figure 2 and in Figure S1.

Statistical analyses

The differences between the seasons were calculated for the individual viruses. For comparison of influenza viruses (Figure 2a) those seasons between 2014/15 to 2018/19 were chosen, which were comparable with respect to influenza type distribution. For these selected seasons the average number of cases for each week weighted by the number of tested patients was computed and then the cumulative number of cases for the duration of activity was obtained. The total number of cases from week of lockdown until end of activity was computed for season 2019/20 and the same computation was performed for the corresponding period of the comparator seasons to obtain the expected number of cases. The hypothesis of equality of the number of observed and expected cases was tested by chi² tests with 1 degree of freedom assuming a Poisson distribution. The influenza season 2019/2020 already peaked between calendar weeks 04 and 06/2020. Based on data of previous influenza seasons in Austria an end of the influenza season would have been expected at around week 15 to 16/2020. By implementing the lockdown measures, the influenza season 2019/20 was ended earlier than expected and its course differed significantly from that of previous seasons ($p<0.001$) (Table 2).

For comparison of seasonal RSV and hMPV (Figure 2b, c), seasons were chosen with respect to the shape of the seasonal activity distribution until the week corresponding to the week of lockdown 2019/20. Also for RSV a sharp decrease was observed after the nationwide lockdown and, although this year's RSV activity was generally low, reduction in the circulation of RSV detected after week 12 was significantly different compared to previous seasons ($p<0.001$). Also, the lockdown measures led to a significant decrease in the number of hMPV detections ($p<0.001$) (Table 2), which was especially impressive, as the hMPV season 2019/20 started with a very high hMPV activity. For both viruses circulation remained low until week 28. Detailed analyses on the reduction of cumulative cases are provided in Supplementary material Figure S2.

To compare the non-seasonal RHIV circulation between different years, the cumulative number of cases between calendar week 12 (start of lock down) and week 22 was computed for all seasons (Figure 2d). The 5 seasons 2014/15 to 2018/19 were compared to season 2019/20 by chi² test with 5 degrees of freedom. Also for RHIV a statistically significant decrease of cases was observed after the lockdown ($p<0.001$) (Table 2).

Discussion

The present data clearly show that the national lockdown in Austria had a significant impact on the prevalence of different respiratory viruses in Austria (Table 2). Interestingly, the decrease of cases happened already within one week after the start of the lockdown. This could be explained by the short incubation periods of the viruses analyzed. Recently, an Italian study described that lockdown measures lead to reduction effects onto the epidemic of chickenpox, rubella, pertussis or measles [9], showing that a lockdown may reduce the prevalence of different infectious diseases.

In addition, RT-PCR testing for SARS-CoV-2 virus [10], was performed with all sentinel samples received from December 6th 2019. As shown in Figure 1 also SARS-CoV-2 cases decreased after the lockdown. Until March (week 11/2020) no SARS-CoV-2 positive samples were detected by this system supporting the current view that SARS-CoV-2 was not yet circulating in 2019 in Austria.

Interestingly, the number of RHIV increased again from week 25 (Figure 2d). From week 16 on lockdown measures were stepwise reduced in Austria, including reopening of shops (from week 16), restaurants (week 20), schools (week 21), hotels and indoor events up to 100 persons (week 22). It seems that these measures had only minor immediate effects on RHIV circulation. Obligation to wear face masks was released for many locations on week 25 and this was in timely relation with a particularly steep increase of RHIV circulation. Albeit Rhinoviruses have different properties and a shorter incubation time than SARS-CoV-2, circulation of these viruses may potentially reflect the efficiency of measures taken against transmission of respiratory viruses in a population.

References

1. (ECDC) ECfDPaC. Risk assessment: Outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): increased transmission beyond China – fourth update. European Center for Disease Prevention and Control 2020, https://www.ecdc.europa.eu/en/publications-data/outbreak-severe-acute-respiratory-syndrome-coronavirus-2-sars-cov-2-increased.
2. S. Wurtzer VM, J.M. Mouchel, L. Moulin. Time Course Quantitative Detection of SARS-CoV-2 in Parisian Wastewaters Correlates With COVID-19 Confirmed Cases. *medRxiv prep.* 2020;10.1101/2020.04.12.20062679 Google Scholar.
3. Control ECfDPa. Threat assessment brief: Outbreak of novel coronavirus disease 2019 (COVID-19): Situation in Italy. https://wwwecdceuropaeu/en/publications-data/outbreak-novel-coronavirus-disease-2019-covid-19-situation-italy. 2020.
4. Control ECfDPa. Coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK –seventh update. https://wwwecdceuropaeu/sites/default/files/documents/RRA-seventh-update-Outbreak-of-coronavirus-disease-COVID-19pdf. 2020.
5. Redlberger-Fritz M, Kundi M, Popow-Kraupp T. Detailed Report on 2014/15 Influenza Virus Characteristics, and Estimates on Influenza Virus Vaccine Effectiveness from Austria's Sentinel Physician Surveillance Network. *PLoS One*. 2016;11(3):e0149916.
6. Aberle SW, Aberle JH, Sandhofer MJ, Pracher E, Popow-Kraupp T. Biennial spring activity of human metapneumovirus in Austria. *Pediatr Infect Dis J.* 2008;27(12):1065-8.

7. Lu X, Holloway B, Dare RK, Kuypers J, Yagi S, Williams JV, et al. Real-time reverse transcription-PCR assay for comprehensive detection of human rhinoviruses. *J Clin Microbiol.* 2008;46(2):533-9.
8. van Elden LJ, van Loon AM, van der Beek A, Hendriksen KA, Hoepelman AI, van Kraaij MG, et al. Applicability of a real-time quantitative PCR assay for diagnosis of respiratory syncytial virus infection in immunocompromised adults. *J Clin Microbiol.* 2003;41(9):4378-81.
9. Belingheri M, Paladino ME, Piacenti S, Riva MA. Effects of COVID-19 lockdown on epidemic diseases of childhood. *J Med Virol.* 2020;10.1002/jmv.26253.
10. Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu DK, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Euro Surveill.* 2020;25(3).

Declarations

Author Contributions:

MRF: data analysis, first draft and revision of the manuscript
MK: statistical analysis
SWA: data analyses
EP: first draft and revision of the manuscript

Competing Interest Statement:

The authors declare no competing interests.

Tables

Table 1: Detailed information on the number of samples tested for Influenza virus, Respiratory Synzytial Virus (RSV), human Metapneumovirus (hMPV) and Rhinovirus (RHIV) and the number of positive samples during the seasons 2014/15 to 2019/20

		Influenza and SARS-CoV2 positive							subset additionaly tested positive for		
n	N analysed overall	Influenza overall	A(H1N1) pdm09	A(H3N2)	A/ unsubtyped	Influenza B	SARS-Cov2	n subset additionally tested	RSV	hMPV	Rhiv
5	4106	1232	250	649	60	273	na	541	212	24	182
6	4025	894	309	101	3	481	na	472	162	25	172
7	4426	1042	21	994	2	25	na	629	364	17	157
8	6873	2334	665	137	60	1472	na	1084	231	81	240
9	2047	587	326	154	2	105	na	899	170	20	242
0	4014	1122	352	489	43	238	63	919	92	72	272

Table 2: Results of statistical analyses (chi² test): number of cumulative detections after the lockdown in 2019/20 compared to the number of observed / estimated detections in the equivalent time period during

the previous seasons for influenza viruses, Respiratory Synzytial Virus (RSV), human Metapneumovirus (hMPV) and Rhinovirus (RHIV)

Virus	N detections after lockdown	N detections observed/estimated in equivalent period during previous seasons	p-value
Influenza	36	150	<0.001
RSV	19	82	<0.001
hMPV	6	23	<0.001
RHIV	17	28	<0.001

Figures

year	2019													2020					
week	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6
Influenza	0	0	0	0	0	0	1	1	0	1	4	54	14	13	17	77	156	183	153
RSV	1	0	0	0	0	1	1	2	2	0	0	2	1	1	2	9	7	13	10
hMPV	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3	4	10	4
RHIV	4	4	7	10	4	11	7	7	11	8	13	12	4	2	5	7	14	5	7
SARS-CoV-2									0	0	0	0	0	0	0	0	0	0	0

year	2020																					
week	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Influenza	109	69	83	86	66	30	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSV	6	7	5	10	4	15	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hMPV	6	5	6	10	9	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHIV	4	4	5	17	16	16	8	2	3	2	0	1	0	0	1	0	0	1	8	13	11	18
SARS-CoV-2	0	0	0	0	6	18	11	9	10	5	4	0	0	0	0	0	0	0	0	0	0	0

Figure 1

Number of Influenza virus, Respiratory Syncytial Virus (RSV), human Metapneumovirus (hMPV) and Rhinovirus (RHIV) detections per week during the period between week 40/2019 and 28/2020. Color coding shows the intensity of virus circulation for each virus, green … no activity, yellow…sporadic detections, orange … medium activity, red … peak activity, red arrow indicates state of lockdown

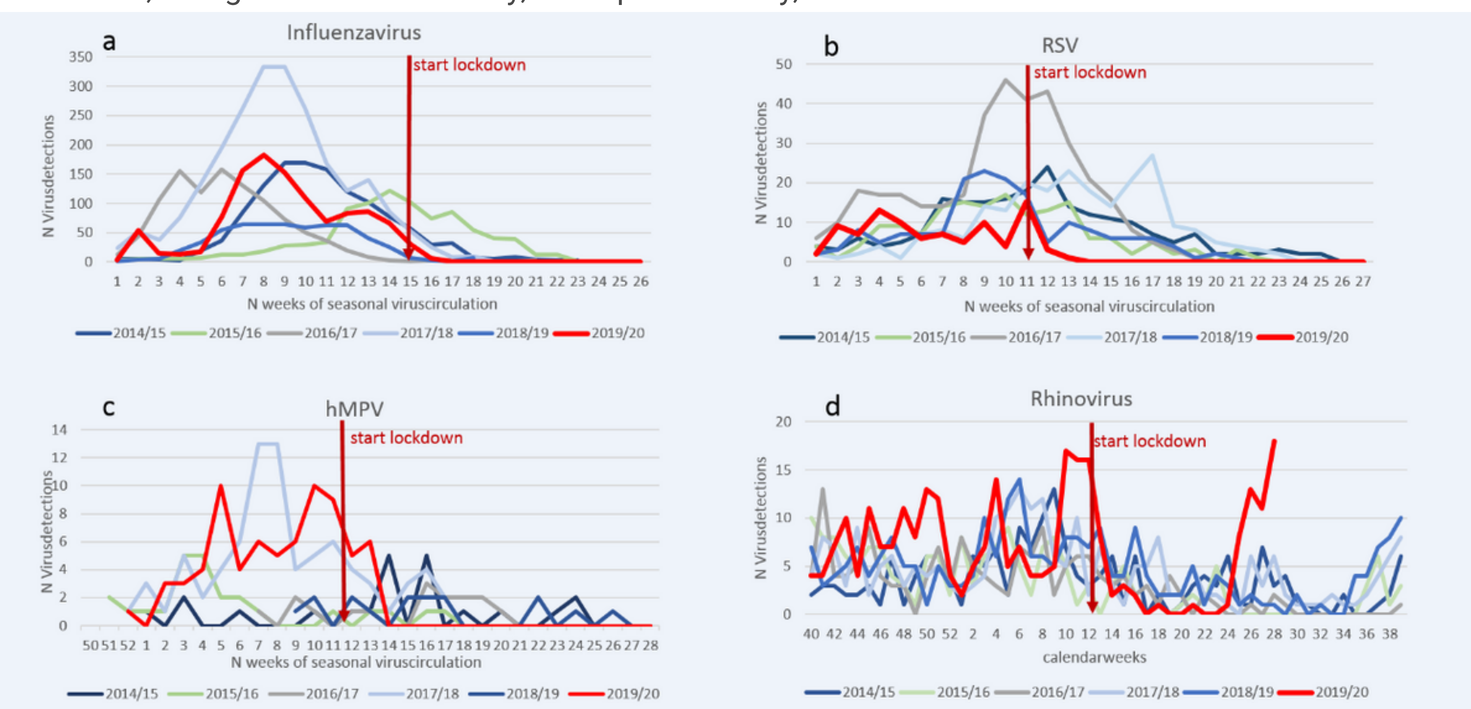

Figure 2

Pattern in the circulation dynamics of (a) influenza virus, (b) Respiratory Syncytial Virus (RSV), (c) human Metapneumovirus (hMPV) and (d) Rhinovirus (RHIV) of the six consecutive seasons 2014/15 to 2019/20. As Influenza, RSV, and hMPV exhibit clear seasonal activity, for a better comparability the weeks of the seasonal virus circulation was indicated. (a) (b) and (c): first week of seasonal virus circulation was defined as the first week of each season where >5% of samples were tested positive; as RHIV circulation has no expressed seasonality the calendar weeks are indicated

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFigureS1.pdf
- SupplementarymaterialstatisticsFigS2.pdf