

Impact of COVID-19 Pandemic on Non-COVID-19 Respiratory Viral Infections in Children, and Lessons for Future

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ABSTRACT

Objective: To assess the impact of precautionary measures taken to curb the transmission of Severe Acute Respiratory Syndrome Corona Virus-2 (SARS-CoV-2) infection on hospitalization rates in children due to other (non-COVID-19) respiratory viral infections.

Study design and setting: A retrospective study was conducted in a tertiary care centre, Bahrain which included children up to 14 years old who were hospitalised with symptoms suggesting respiratory viral infections and had respiratory viral panel PCR tested during their admission. The study cohort was extracted from three winter seasons in Bahrain (pre-pandemic, peri-pandemic and post-pandemic). The occurrence of positive viral panel PCR for non-COVID-19 respiratory viral infections during the coronavirus disease 19 (COVID-19) pandemic and post pandemic was analysed and compared with the pre-pandemic winter seasons.

Results: The study identified 1008 paediatric admissions over the three study periods. A significant reduction in the total admissions to the paediatric ward was observed during the peak pandemic period. Only 62 children admitted during the peak pandemic winter compared to 693 children admitted to the paediatric ward during the pre-pandemic winter season, and 253 children admitted during the post-pandemic winter seasons of Bahrain.

The study has shown an incidence reduction of 89% (RR 0.11 (95% CI 0.016 to 0.768) p=0.0259) and 60% (RR 0.40 (95% CI 0.242 to 0.670) p=0.0005) in the occurrence of RSV infection among the admitted children during the peripandemic and post-pandemic winter periods respectively. There was a 93% reduction (RR 0.07 (95% CI 0.0045 to 1.311) p=0.0611) and 71% reduction (RR 0.29 (95% CI 0.142 to 0.580) p<0.0005) in the incidence of influenza virus infection in admitted children during the pandemic and post pandemic periods respectively. On the other hand, the identification of human rhinovirus/ enterovirus was found to be nearly 4 times (RR 4.11 (95% CI 2.531 to 6.683) p<0.0001) and 3 times more likely (RR 3.0 (95% CI 2.063 to 4.380) p<0.0001) during the pandemic and post pandemic winter respectively.

Conclusion: The study showed the impact of the precautionary measures on the occurrence of non-COVID-19 respiratory viral infections that led to hospitalisation in children. The overall hospitalisation rate was reduced during the study period compared to the period when children were not exposed to the SARS-CoV-19 infection. The results could be a useful tool for the future discussion on quality assurance of health services recommended for use in schools and other institutions where large number of people gathers facilitating viral transmission.

Keywords: COVID-19 pandemic; SARS-CoV-19; Respiratory viral panel; Gastrointestinal viral panel

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BACKGROUND

What's known on this subject

Since the day when World Health Organization (WHO) declared coronavirus disease 19 (COVID-19) infection a pandemic in March 2020, many research articles, case reports and case series have been published on various aspects of COVID-19 infection, vaccination, treatment modalities and its impact on social life from different parts of the world. Among the Co-operation Council for the Arab States of the Gulf (GCC) countries, the Kingdom of Bahrain has directed a wide range of precautionary and preventive measures to protect the health and well-being of its population. To date, Bahrain has published more than 30 research articles on the impact of COVID-19 infection on the environment, on our socioeconomic status, on women and work, on the impact of preventive measures on outbreak containment and many more.

What this study adds

This study focuses on how significantly the COVID-19 infection control and precautionary measures taken by the ministry of health, Kingdom of Bahrain during the pandemic has impacted on the hospitalization rates in children as a result of non-COVID-19 viral infections. It has been observed that nonpharmaceutical public health measures (social distancing, wearing mask, hand hygiene, and avoiding social gatherings) were found to be an effective intervention against COVID-19 infection. We hypothesize that, the study results could demonstrate a significant reduction in the transmission of non-COVID-19 respiratory viral infections which may otherwise have led to hospitalization in children during the pandemic.

We highlight some lessons that can be learned from the pandemic to enhance social resilience, and how to be prepared and protect our children from infectious pandemic/epidemics in future.

INTRODUCTION

The COVID-19 pandemic is the most difficult challenge and is the greatest crisis since the Second World War II that has dramatically challenged the human society. As a health crisis and a threat, the COVID-19 pandemic has dramatically impacted the societies, economies, and vulnerable populations, especially children worldwide.

Since the first case was recorded in Wuhan, China, the COVID-19 epidemic has spread to 222 countries and territories with more than 263 million cases, and it has claimed the lives of over 5 million persons [1]. This epidemic has affected the social life, economic wellbeing, and physical and mental health of individuals all over the world. It increases the medical burden even in countries with well-developed medical systems [2].

Worldwide, following the guidelines issued by the World Health Organization (WHO) and by European Centre for Disease Prevention and Control (ECDC), restrictions were applied which aimed at containing Severe Acute Respiratory Syndrome Corona Virus-2 (SARS-CoV-2) diffusion, which included case isolation, contact tracing, quarantine for contacts or following movements from high-risk areas, migration measures, and up to the general lockdown [3].

The restrictions imposed by governments have also affected the paediatric population; specifically, the use of face masks was made mandatory starting from 6 years of age, and access to schools has undergone profound limitations: The generalized lockdown at the beginning of the pandemic led to the physical closure of school activities at all levels, which gradually resumed, initially in remote telematics mode, starting from May 2020 [4]. From September 2020, face to face school activities have resumed for 8 million students worldwide, initially only for kindergarten and primary schools, and afterward for middle and high schools. In the first phase of the pandemic, children appeared to be less affected by SARS-CoV-2, with mild symptoms and lower hospitalization rates than adult cohorts [5].

However, respiratory diseases are recognized as the most frequent cause of mortality and morbidity in infants and young children in the winter and spring period with about five to six infections annually [6,7]. The pathogens most frequently associated with respiratory tract infections in children include Human Rhino Virus (HRV), Respiratory Syncytial Virus (RSV), influenza virus, parainfluenza virus, adenovirus, and also coronaviruses. Furthermore, 10% of respiratory diseases are caused by bacteria [8-10].

The Kingdom of Bahrain has implemented various measures to respond to the COVID-19 pandemic since 24 February 2020, when cases were officially reported in the Kingdom [11]. The precautionary and preventive measures taken by the ministry of health to contain the outbreak of COVID-19 has shown an effective impact on the reduction of hospitalisation in children due to non-COVID-19 viral infections.

This study aims to assess the impact of COVID-19 infection prevention and control measures during the pandemic and postpandemic periods on hospitalization of children with non-COVID-19 respiratory viral infections compared to children admitted during the pre-pandemic winter. In addition, the study analyses the distribution of respiratory viral pathogens detected using the film array viral panel PCR among the hospitalised children during the pandemic, pre-pandemic and the post pandemic period.

We propose that our study results may help for future debate and discussion around public health guidance on appropriate standard infection control measures recommended for use in schools and other institutions where large numbers of people gather facilitating viral transmission.

MATERIAL AND METHODS

Study design and setting

This retrospective study was conducted in King Hamad University

Hospital, a tertiary care centre in Bahrain and was approved by the Institutional Review Board of King Hamad University Hospital, Bahrain (IRB no.538/2022).

The study included children up to 14 years old who were hospitalised in King Hamad University hospital, Pediatric department with symptoms suggesting respiratory viral infections and had respiratory viral panel PCR tested using film array viral panel (bioMérieux) during their admission. The study excluded those children admitted with clinical or laboratory diagnosis of bacterial infection.

The data of all pediatric patients who were hospitalized during the pre-pandemic winter (October 2018 to March 2019) and the pandemic winter season (October 2020 to March 2021) of Bahrain were extracted retrospectively from the electronic health records of the department. The data of all pediatric patients who were hospitalized during the post pandemic winter seasons (October 2021 to March 2022) was collected prospectively from the electronic files of the patients.

The admission symptoms of studied children included cough, fever, running nose, respiratory distress and reduced feeding. All admitted children had close monitoring of the vitals during their hospital stay. Children with severe illness or impending organ failure were admitted to the Pediatric Intensive Care Unit (PICU). Admitted children with clinical diagnosis of viral etiology were subjected to respiratory viral panel PCR test. The various diagnoses among the studied children at the time of discharge included acute upper respiratory tract infection, acute bronchiolitis, viral pneumonia, acute bronchitis (viral induced wheeze), viral tonsillitis, croup, hand foot and mouth disease, viral gingiva stomatitis, herpangina, viral myositis, viral fever with anicteric hepatitis, viral exanthem and febrile seizures.

Statistical methods

The retrospective data were entered in a Microsoft excel sheet and the results were analysed using statistical software SPSS version 27 (IBM, Armonk, NY, USA). The data variable recorded included gestational age at birth, chronological age (in months), gender, symptoms at admission, inflammatory marker (C-reactive protein), need for PICU admission, respiratory viral panel PCR, diagnosis at discharge and the duration of hospital stay.

For the purpose of statistical analyses, the children admitted during the pre-pandemic winter season were considered as the control group. This is the period when children were not exposed to the SARS-CoV-19 infection and there was no implementation of infection control/prevention strategies to be followed by the general population. The children admitted during the pandemic and post pandemic winter season were considered as the exposure groups. Children during this period were exposed to the SARS-CoV-19 infection and the ministry of health, Bahrain has implemented the non-pharmaceutical public health measures (social distancing, wearing mask, hand hygiene, and avoiding public gatherings) to be strictly followed by the general population to contain the outbreak of SARS-CoV-19 transmission.

The median and Inter Quartile Ranges (IQR) were calculated for the age and the duration of hospital stay. The qualitative variables sex, prematurity and need for PICU admission were expressed as frequency and percentages (%). The probability of admitted children having positive viral panel for non-COVID-19 respiratory viral infections during the non-exposure period and exposure to the SARS-CoV-19 infection were calculated. The descriptive Z test statistics were used to calculate the relative risk/ risk ratio with 95% confidence intervals (95% CI) between the exposure and non-exposure groups. The percentage of proportions between the groups were compared using Pearson chi-squared statistic>3.841 at degree of freedom (df=1). p value of \leq 0.05 was considered as statistically significant (Table 1).

RESULTS

The study identified 1008 pediatric admissions over the three periods under examination. A significant reduction in the total admissions to the paediatric ward was observed during the peak pandemic period. Only 62 children were admitted during the peak pandemic winter compared to 693 children admitted to the

Baseline characteristics	Pre pandemic period, when	The period when children were exposed to the SARS-CoV-19 infection	
	the SARS-CoV-19 infection (n=693)	Peak pandemic winter period (n=62)	Post pandemic winter period (n=253)
Age (median with IQR in months)	16 (7-36)	30 (12-63)	17 (7-36)
Male	385 (55.6%)	43 (69.4%)	151 (59.7%)
Female	308 (44.4%)	19 (30.6%)	102 (40.3%)
Preterm (<37 weeks gestational age)	68 (9.8%)	10 (16.1%)	44 (17.4%)
Need for PICU admission	38 (5.5%)	7 (11.3%)	10 (4.0%)
Duration of hospital stay (median with IQR in days)	2 (2-3)	2 (1-3)	2 (1-4)

Table 1: Baseline characteristics of the studied population.

paediatric ward during the pre-pandemic winter season, and 253 children admitted during the post pandemic winter seasons of Bahrain.

Film array viral panel PCR for non-COVID-19 respiratory viral infections

Among 693 children admitted during the pre-pandemic winter, 448 children were subjected to respiratory viral panel PCR. Similarly, among the 62 children admitted during the pandemic winter, 38 children had respiratory viral panel PCR tested. During the post pandemic winter, out of 253 children, 156 children were subjected to respiratory viral panel PCR testing.

The study has shown 16% reduction in the incidence of non-COVID-19 respiratory viral infections in children who required hospitalisation during the COVID-19 pandemic winter compared to the pre pandemic winter. Total admissions during this period however were markedly lower than pre and post-pandemic winters and the apparent 16% reduction was not statistically significant (RR 0.84 (95% CI 0.633 to 1.105) p=0.209). On the other hand, a statistically significant increase in the incidence of non-COVID-19 respiratory viral infections (RR 1.23 (95% CI 1.126 to 1.347) p<0.0001) was observed during the post-pandemic winter season (Table 2).

Subgroup analysis on non-COVID-19 respiratory viral infections

Respiratory Syncytial Virus (RSV) is the common viral infection that causes respiratory illness in children leading to hospitalization. This study has shown an 89% reduction in the incidence of RSV infection in children during the pandemic winter (RR 0.11 (95% CI 0.016 to 0.768) p=0.0259) and 60% reduction in the incidence of RSV infection during the post pandemic winter (RR 0.40 (95% CI 0.242 to 0.670) p=0.0005) compared to the pre-pandemic winter.

Influenza virus was found to be the second most common viral infection causing respiratory illness in children. Both influenza type A (subtypes *H1N1*, *H3N2*) and influenza type B viruses were detected during the study period. Similar to RSV infection, although there was 93% reduction in the incidence of influenza virus infection (RR 0.07 (95%CI 0.0045 to 1.311) p=0.0611), this figure did not reach statistical significance due to the small sample size giving a wide confidence interval and no cases were reported during the peri-pandemic winter. On the other hand, a statistically significant reduction of 71% in the incidence of influenza virus infection was observed during the post pandemic winter (RR 0.29(95% CI 0.142 to 0.580) p<0.0005) (Table 3).

Film array viral panel PCR for	Im array viral panel PCR for her respiratory viral infections Pre pandemic period, when children were not exposed to the SARS-CoV-19 infection (n=693)	The period when children were exposed to the SARS-CoV-19 infection	
other respiratory viral infections		Peak pandemic winter period (n=62)	Post pandemic winter period (n=253)
Positive	310	22	133
Negative	138	16	23
RR with 95% CI		RR 0.84	RR 1.23
		(95% CI 0.633 to 1.105)	(95% CI 1.126 to 1.347)
p-value		p=0.209	P<0.0001*

Note: (*) a significant increase in positive viral panel PCR for non-COVID 19 respiratory viral infection (RR 1.23(95% CI 1.126 to 1.347) p< 0.0001) was observed compared to pre pandemic period.

 Table 2: Incidence of non-COVID-19 respiratory viral infections during the study period.

Film array viral panel PCR for respiratory viral infections	Pre pandemic period, when children were not exposed to the SARS-CoV-19 infection (n=693)	The period when children were exposed to the SARS-CoV-19 infection	
		Peak pandemic winter (n=62)	Post pandemic winter (n=253)
Not done	188 (27.1%)	22 (35.5%)	61 (24.1%)
Negative viral panel	138 (30.8%)	16 (42.1%)	23 (14.7%)
Respiratory syncytial virus	107(23.9%)	1 (2.6%)	15 (9.6%)
Influenza virus	80 (17.9%)	0 (0.0%)	8 (5.1%)
Type A H3N2	26 (5.8%)	0 (0.0%)	7 (4.5%)

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Type A H1N1	21 (4.7%)	0 (0.0%)	0 (0.0%)
Туре В	17 (3.8%)	0 (0.0%)	1 (0.6%)
Type A H1N1+H3N2	16 (3.6%)	0 (0.0%)	0 (0.0%)
Human rhino virus/non-polio enterovirus	43 (9.6%)	15 (39.5%)	45(28.8%)
Human parainfluenza virus	31 (6.9%)	2 (5.3%)	27(17.3%)
Type 2	27 (6.0%)	0 (0.0%)	12 (7.7%)
Туре 3	2 (0.4%)	2 (5.3%)	13 (8.3%)
Type 4	2 (0.4%)	0 (0.0%)	2 (1.3%)
Human adeno virus	12 (2.7%)	2 (5.3%)	4 (2.6%)
Metapneumo virus	8 (1.8%)	0 (0.0%)	3 (1.9%)
Human rhino virus/non-polio enterovirus+Respiratory syncytial virus	6 (1.3%)	0 (0.0%)	9 (5.8%)
Human rhino virus/non-polio enterovirus+Human adeno virus	4 (0.9%)	0 (0.0%)	2 (1.3%)
Human rhino virus/non-polio enterovirus+Metapneumo virus	2 (0.4%)	0 (0.0%)	0 (0.0%)
Human rhino virus/non-polio enterovirus+Corona virus HCoV- OC 43	2 (0.4%)	0 (0.0%)	2 (1.3%)
Human rhino virus/non-polio enterovirus+Human parainfluenza virus type 3	2 (0.4%)	0 (0.0%)	3 (1.9%)
Respiratory syncytial virus+Human adeno virus	2 (0.4%)	0 (0.0%)	0 (0.0%)
Respiratory syncytial virus+Corona virus HKU1	2 (0.4%)	0 (0.0%)	2 (1.3%)
Corona virus HKU1	2 (0.4%)	0 (0.0%)	1 (0.6%)
Human rhino virus/non-polio enterovirus+Human parainfluenza virus type 2	1 (0.2%)	0 (0.0%)	0 (0.0%)
Human rhino virus/non-polio enterovirus+Human adenovirus +Metapneumo virus	1 (0.2%)	0 (0.0%)	0 (0.0%)
Respiratory syncytial virus+Human parainfluenza virus type 3	1 (0.2%)	0 (0.0%)	0 (0.0%)
Human adenovirus+Corona virus HKU1	1 (0.2%)	0 (0.0%)	1 (0.6%)

Influenza virus type B+Human parainfluenza virus type 2	1 (0.2%)	0 (0.0%)	0 (0.0%)
Epstein-Barr virus	1 (0.2%)	0 (0.0%)	0 (0.0%)
Herpes simplex virus type 1	1 (0.2%)	0 (0.0%)	0 (0.0%)
Human rhino virus non-polio enterovirus+Corona virus HKU1	0 (0.0%)	0 (0.0%)	1 (0.6%)
Respiratory syncytial virus+Human parainfluenza virus type 4	0 (0.0%)	0 (0.0%)	2 (1.3%)
Respiratory syncytial virus +Metapneumo virus	0 (0.0%)	0 (0.0%)	1 (0.6%)
Human adeno virus+Metapneumo virus	0 (0.0%)	0 (0.0%)	1 (0.6%)
Human adeno virus+Human parainfluenza virus type 4	0 (0.0%)	0 (0.0%)	1 (0.6%)
Human parainfluenza virus type 3 +SARS CoV	0 (0.0%)	0 (0.0%)	1 (0.6%)
Corona virus HCoV-OC 43	0 (0.0%)	0 (0.0%)	2 (1.3%)
SARS CoV	0 (0.0%)	0 (0.0%)	2 (1.3%)

 Table 3: Non-COVID-19 respiratory viral infections identified during the study period.

In contrast to the findings of reduction in the incidence of RSV and influenza virus, the study has shown nearly 4 times increase in the incidence of human rhino virus/non-polio enterovirus (RR 4.11(95% CI 2.531 to 6.683) p<0.0001) during the pandemic winter and 3 times increase during the post pandemic winter (RR 3.0 (95% CI 2.063 to 4.380) p<0.0001) compared to the pre pandemic period.

Human parainfluenza was found to be the fourth most common virus that cause respiratory illness and led to hospitalisation during the study period. Human parainfluenza virus type 2, type 3 and type 4 were detected using the film array respiratory viral panel PCR. Our study has shown, no statistical evidence of a reduction in the incidence of human parainfluenza virus during the peri-pandemic winter (RR 0.76 (95% CI 0.189 to 3.057) p=0.6998). However, the incidence was 2.5 times more likely during the post-pandemic winter (RR 2.50 (95% CI 1.543 to 4.053) p=0.0002).

The incidence of adenovirus was found to be 3 times more likely in the peri-pandemic winter compared to the pre-pandemic winter period, although this figure was not statistically significant due to the small numbers (RR 3.00 (95% CI 0.869 to 9.993) p=0.0827). Similarly, the outcome has no statistical significance and the results were inconclusive in the post pandemic winter (RR 1.00 (95% CI 0.313 to 2.924) p=0.9389).

The study has shown no statistical evidence of a reduction in the incidence of metapneumovirus during the peri-pandemic winter (RR 0.68 (95% CI 0.040 to 11.515) p=0.7875) or during the

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post pandemic winter (RR 1.07 (95% CI 0.290 to 4.008) p=0.9120).

Co-infection of other respiratory viruses

The film array viral panel PCR used during the study period has detected viral co-infections among the hospitalized children. During the peri-pandemic winter, a non-significant reduction in the incidence of co-infection of human rhino virus/non-polio enterovirus with other respiratory viruses was found (RR 0.65 (95% CI 0.090 to 4.773) p=0.6763). However, the incidence was 2.7 times more likely during the post-pandemic winter (RR 2.71 (95% CI 1.434 to 5.130) p=0.0022).

The incidence of co-infection with RSV plus other respiratory viruses did not differ significantly during the peri-pandemic winter (RR 1.04 (95% CI 0.060 to 18.580) p=0.9752) nor the post-pandemic winter (RR 2.9 (95% CI 0.842 to 9.790) p=0.0917) when compared to the pre-pandemic winter.

To the same pattern was found in relation to co-infection of adenovirus with other respiratory viruses, the incidence was 3.8 times more likely in the pandemic (RR 3.83 (95% CI 0.159 to 92.642) p=0.4077) and about 8.6 times more likely in the post pandemic winter (RR 8.61 (95% CI 0.902 to 82.221) p=0.0.0613) however neither of these apparent differences were statistically significant due to very small sample size in the groups.

In addition, the film array viral panel PCR used during the study period has detected corona viruses other than SARS-

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CoV-19. The other types of corona virus detected were *HKU1*, HCoV-OC43 and SARS-CoV-2 (which was a pandemic in 2002). The incidence of these corona viruses has shown no statistically significant variation during the study period.

To summarize, a statistically significant reduction in the incidence of RSV and influenza viruses, which spread by respiratory droplets (airborne) from nose and throat of infected people was found during the pandemic and the post pandemic winter periods. On the other hand, the study has shown a statistically significant increase in the incidence of human rhino virus/enterovirus that spread by respiratory particles *via* contact transmission during the pandemic and post pandemic period. In contrast, the incidence of parainfluenza virus which spreads by contact with respiratory particles as well by respiratory droplets (airborne) was found to be increased during the post pandemic period while a reduction in the incidence of the para influenza was observed during the pandemic.

DISCUSSION

The coronavirus disease 2019 pandemic, and the subsequent infection control measures, mainly non-pharmaceutical interventions has led to a substantial shift in the spectrum of respiratory tract infections. In many regions, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) was the most common viral respiratory pathogen while the circulation of influenza and Respiratory Syncytial Virus (RSV) was decreased [12-14].

Sabeena et al., [15], conducted a systemic review and metaanalysis on nine qualified studies on the impact of COVID-19 pandemic influenza surveillance from the WHO European region, Canada, Japan, Germany, Italy, Spain, South Africa, and the United States of America. They found a significant decline in the influenza surveillance during the COVID-19 pandemic except in Canada. Edwards [16], commented in his article about the dramatic decline in both RSV and influenza associated with mitigation strategies implemented in response to the Severe Acute Respiratory Syndrome Corona Virus-2 (SARS-CoV-2) pandemic.

In our study, during the COVID-19 pandemic, we observed 93% reduction in the incidence of influenza infection and 89% reduction in the incidence of RSV infection which otherwise leads to hospitalisation in children.

The restrictions implemented during the COVID-19 pandemic were aimed at reducing SARS-CoV-2 infections, however it obviously decreased the cases of other infectious diseases such as non COVID-19 respiratory tract infections. The cross-sectional study conducted by Tanislav et al., [17], showed a remarkable decrease in non-SARS-CoV-2 related infections of the respiratory tract in adults as well as in children during the COVID-19 pandemic, among both general practitioners and pediatricians treating fewer patients with lower and upper respiratory tract infections.

The current study has limitations as the study results were based on the data derived from a single centre. However, the study results may inform future discussion on infection control The gradual increase in hygiene awareness brought about as a result of the COVID-19 pandemic would also have influenced the reduced rates detected for non COVID-19 respiratory tract and gastrointestinal tract respectively. It can be speculated that the educational benefit gained in the COVID-19 pandemic could contribute to controlling the spread of infectious diseases in the future. The lesson learned for future is the adherence to airborne precautions has significantly reduced the hospitalisation in children, and by providing more awareness to contact precautions will further reduce the rate of hospitalisation in children during any seasons of the year.

CONCLUSION

The non-pharmacological interventions i.e., social distancing, wearing mask and hand hygiene implemented to contain the transmission of SARS-CoV-19 infection during the COVID-19 pandemic has significantly reduced the incidence of RSV and influenza virus infection that spreads through respiratory droplets (airborne transmission) of the infected people. On the other hand, the occurrence human rhino virus/enterovirus infection that spreads through respiratory particles (contact transmission) that survive on surfaces for many hours were found to be increased during the study period. The authors suggest that, in certain environments, the periodic introduction of non-pharmacological infection control measures such as mask-wearing and improved hand hygiene during periods of peak viral circulation may curb the spread of infection and reduce the impact on the individual and as well as the institution.

AUTHOR CONTRIBUTIONS

NA collected the data, AA did the initial analysis, interpretation of data and drafted the initial manuscript. JJ did the final data analysis with interpretation of study results and drafted the final manuscript as submitted. AF revised the manuscript, the data analysis and reviewed the manuscript critically for the intellectual content. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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