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Decline of Influenza and Respiratory Viruses With COVID-19 Public Health Measures: Alberta, Canada

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Abstract

Objective: To determine the incidence of influenza and noninfluenza respiratory viruses (NIRVs) pre-/post-implementation of public health measures aimed to decrease coronavirus disease 2019 (COVID-19) transmission using population-based surveillance data. We hypothesized that such measures could reduce the burden of respiratory viruses (RVs) transmitting via the same routes.

Patients and Methods: An interrupted time-series analysis of RV surveillance data in Alberta, Canada, from May 2017 to July 2020 was conducted. The burden of influenza and NIRVs before and after intervention initiation at week 11 was compared. The analysis was adjusted for seasonality, over-dispersion, and autocorrelation.

Results: During the study period, an average of 708 and 4056 weekly respiratory multiplex molecular panels were conducted pre-/post-intervention, respectively. We found significant reductions in test positivity rates in the postintervention period for influenza (-94.3%; 95% CI, -93.8 to 97.4%; $P<.001$) and all NIRVs (-76.5%; 95% CI, -77.3 to -75.8%; $P<.001$) in the crude model, and -86.2% (95% CI, -91.5 to -77.4%: $P<.001$) and -75% (95% CI, -79.7 to -69.3%; $P<.001$), respectively, in the adjusted models. Subanalyses for individual viruses showed significant decreases in respiratory syncytial virus, human metapneumovirus, enterovirus/rhinovirus, and parainfluenza. For non–severe acute respiratory coronavirus 2 human coronaviruses, the decline was not statistically significant after adjustment (-22.3%; 95% CI, -49.3 to +19%, $P=.246$).

Conclusion: The implementation of COVID-19 public health measures likely resulted in reduced transmission of common RVs. Although drastic lockdowns are unlikely to be required given widespread COVID-19 vaccination, targeted implementation of such measures can lower RV disease burden. Studies to evaluate relative contributions of individual interventions are warranted.

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As of July 16, 2021, 188,655,968 confirmed cases of coronavirus disease 2019 (COVID-19), including 4,067,517 deaths, have been reported to the WHO.[1] Canada has reported 1,423,177 cases (including 26,499 deaths), with the province of Alberta (population 4.4 million) reporting 232,676 cases and 2,314 deaths.[2-4] The first case of COVID-19 in Canada was diagnosed on January 25, 2020 (epidemiological week 5), in Toronto, Ontario, with Alberta confirming its first case on March 5, 2020 (week 10).[5,6] With the declaration of COVID-19 as a global pandemic on March 11, 2020 (week 11), a bundle of public health measures were immediately adopted by the Alberta Government to limit community spread.[7] This included closure of all preschool to university in-person classes, bans on gatherings of more than 50 people, cessation to in-person restaurant dining, as well as closures of fitness centers, museums, children's play centers, playgrounds, child-minding facilities, bars, nightclubs, bingo

centers, casinos, public recreation centers, and arenas.[7] Public health authorities also promoted a physical distancing campaign which advised staying at home if possible, working from home, minimizing social activities outside immediate household circles, vigilance in monitoring for potential symptoms, and self-quarantine if one developed any symptoms. Testing for COVID-19 was provided freely via local public health departments.[4] Testing was initially for symptomatic patients only but expanded to widespread asymptomatic testing on April 23, 2020.[4] As shown in other jurisdictions,[8,9] these interventions likely have contributed to the decrease in incidence of COVID-19 in Alberta during the first wave, thus the "flattening of the curve."[10]

The occurrence of the COVID-19 pandemic in Alberta and the implementation of public health interventions temporally coincided with the seasonal activities of influenza, respiratory syncytial virus (RSV), and other respiratory viral infections, which typically last until week 18 or beyond.[11] In Alberta, a province-wide laboratory surveillance program for all influenza and noninfluenza respiratory viruses (NIRVs) diagnosed by multiplex polymerase chain reaction (PCR) assays was started in 2016; with weekly reports made available to the public online.[12] Through monitoring of our surveillance data, a sharp decrease in the incidence of influenza infection was noticed after week 11. Sentinel surveillance data from northern and southern hemispheres have similarly described a substantial decrease in influenza transmission during this pandemic.[13-20] In this analysis, we aim to study the incidence of influenza, as well as five common NIRVs pre- and pos-tinitiation of public health interventions using our population-based surveillance data. Emerging evidence strongly indicates that the burden of NIRVs could be comparable to that of influenza.[21] We hypothesize that public health measures that aim to decrease COVID-19 transmission through droplets and close contact could simultaneously reduce the burden of other respiratory viruses transmitted via the same routes. Such data may have important implications for health care planning in the northern hemisphere during future respiratory virus seasons.

PATIENTS AND METHODS

An interrupted time-series analysis was conducted using population-based respiratory virus surveillance data in Alberta, Canada, from May 2017 to July 2020, covering three winter seasons. In Alberta, all data on virologic testing for acute respiratory infections are centralized by the Public Health Laboratory for surveillance reporting. In acute-hospital and continuing-care settings, respiratory samples collected from symptomatic individuals (with the aim to guide isolation precautions and clinical management) are subjected to multiplex-PCR testing for a panel of respiratory viruses. This includes influenza A (H1-pdm09 and H3 subtypes) and B viruses; RSVs A and B; human coronaviruses (hCoV-HKU1, 229E, OC43, NL63); human metapneumoviruses (hMPVs); human entero/rhinoviruses (hERVs), parainfluenza viruses (PIV 1-4) and adenovirus. Details on sample processing, laboratory methods, and the assays' analytical performance have been described.[22] Multiplex respiratory virus testing was not conducted on asymptomatic individuals. In community settings, PCR-based testing for influenza A and B were performed prepandemic using an influenza-only PCR with multiplex respiratory viral panel PCR testing implemented from January to March 2020 as part of the pandemic response.[23] Data for this study, including virological results and testing time, during the period from week 19, 2017 to week 30, 2020 was extracted from the laboratory's information system and only anonymous data were analyzed.

To construct the weekly time series, the count of positive tests and the total number of tests performed each week during the study period were used to calculate the test positivity rate (TPR) for influenza and NIRVs. As an indicator, TPR intrinsically adjusts for the volume of tests performed, and the trend in the TPR is widely considered by public health authorities as a predictor of the extent of community transmission and has

been used in similar analyses from other judistrictions.[24-28] To test our hypothesis and evaluate the impact of pandemic public health measures on incidence of laboratory-confirmed influenza and NIRV infections, we conducted interrupted time series (ITS) analysis using level change impact models as described by Bernal et al.[29] The ITS with level change model was deemed the most appropriate statistical method as there was a clearly defined time of initiation of interventions at week 11 of 2020, thus separating the pre- and postintervention periods.

We created the variable T denoting the time elapsed from the start of the study period with the unit representing weekly frequency of observations in time series, and variable X_t indicating the preintervention period (coded as 0) and the postintervention period (coded as 1). The dependent outcome variable Y_t denoted the incidence of respiratory viruses in pre- and postintervention periods. In Poisson regression, the incidence rate (Y_t specified as a parameter μ) is determined as a set of regressor variables (X and T). The segmented regression analysis we used can be expressed as:
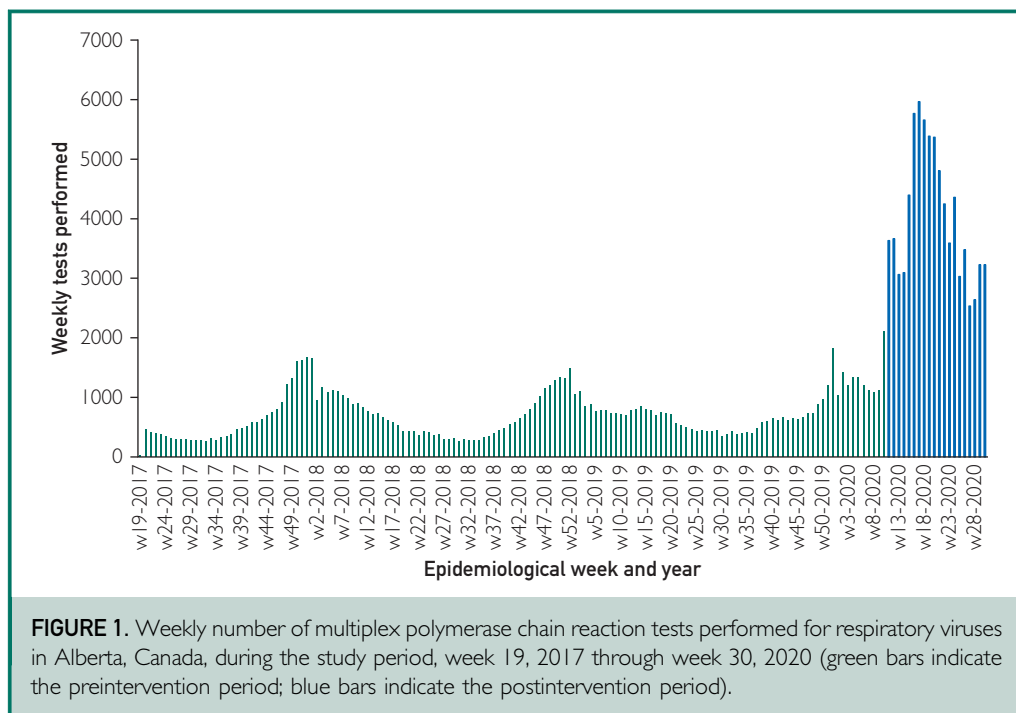
$$\mu = t \exp\left(\beta_1 T + \beta_2 X_t\right).$$

We used log-transformed number of tests as an offset term in the model. We examined histograms/density plots of the untransformed and log-transformed test variables (Supplemental Figure 1, available online at http://www.mayoclinicproceedings.org). Incidence-rate ratios (IRRs) (which refers to the change in the TPR for each virus in relation to the time of the intervention) and 95% CIs were derived from the Poisson model to characterize the impact of the intervention (X_t) on dependent variable Y_t. We fitted separate models for the most common respiratory viruses, including influenza, RSV, hCoVs, hMPV, hERV, and PIV. We first fitted the crude models and generated predicted values to create a plot of the model. We then generated the counterfactuals by removing the effect of interventions using the formula $p1 = p/\exp(\beta[intervention])$. The models were then adjusted for both overdispersion and seasonality. To adjust for seasonality, we used Fourier terms (pairs of sine and cosine functions). We examined the autocorrelation and partial autocorrelation plots of residuals from the predicted models. To correct for the weak-to-moderate residual autocorrelation, we computed Newey-West standard errors and corresponding CIs for the seasonally adjusted models.[30] Finally, on the seasonally adjusted graph we plotted a line as if all weeks were the average to produce a de-seasonalized trend. To assess for influence of age on the testing results, the model was specifically run using respiratory testing results from patients aged 0–5 years, 0–16 years, and all ages (as many respiratory viruses commonly occur in those aged 0–5 years).[31,32] The average virus-specific incidence rate per 100,000 people was also plotted for those aged 0–5 years, 0–16 years, and all ages. For the purposes of health care delivery, individuals aged 16 years or older are considered adults in Alberta.

All analyses were performed using Stata 14.2 software (StataCorp LP, 2015, College Station, TX, USA). The Stata code for the performed analyses is available in Supplemental Methods (available online at http://www.mayoclinicproceedings.org).

RESULTS

During the 3-year study period, 185,978 multiplex-PCR tests were performed, including 104,854 (average 708 tests/week) before and 81,124 (average 4056 tests/week) after the implementation of public health interventions at week 11, 2020. The average number of tests performed during the corresponding weeks (from week 11 to the week 30) in 2018 and 2019 was 492 and 607 per week, respectively (Figure 1). When comparing influenza, NIRVs, and individual respiratory viruses, the mean weekly virus-specific incidence rate (per 100,000 population) decreased postintervention in 2020 for all categories except hERV (Supplemental Figure 2, available online at http://www.mayoclinicproceedings.org). No difference was noted when these same data were compared for individuals aged 0–5 and 0–16 years. The increase in hERV noted in incidence rates for all ages postintervention

FIGURE 1. Weekly number of multiplex polymerase chain reaction tests performed for respiratory viruses in Alberta, Canada, during the study period, week 19, 2017 through week 30, 2020 (green bars indicate the preintervention period; blue bars indicate the postintervention period).

was not observed when the two specific pediatric age groups were evaluated.

For influenza (A and B), the cumulative TPR was 17.18% (18,015/104,854) during the preintervention and 0.98% (790/80,976) in the postintervention periods, respectively. The cumulative TPRs for RSV, hCoVs, hMPV, hERV, and PIV were 6.99% (7,331/104,854), 3.79% (3,972/104,854), 4.2% (4,407/104,854), 15.81% (16,582/104,854), and 4.4% (4,617/104,854), respectively, in the preintervention period, and 0.56% (451/80,976), 1.21% (979/80,976), 1.07% (867/80,976), 3.89% (3,151/80,976), and 0.31% (253/80,976), respectively, in the postintervention period. The mean weekly TPRs for these infections during the periods are reported in Table 1. The corresponding test volumes and TPR for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing performed from March 2020 to July 2020 is shown in Supplemental Figure 3 (available online at http://www.mayoclinicproceedings.org). The higher volume of tests postintervention is due to COVID-19 testing, conducted province-wide.

The IRRs were calculated (Table 2). We found significant reductions in the TPRs in the postintervention period for influenza of -94.3% (95% CI, -93.8 to -94.7%; $P<.001$) and all NIRVs of -76.5% (95% CI, -77.3 to -75.8%; $P<.001$) as shown in the crude model, and -86.2% (95% CI, -91.5% to -77.4%; $P<.001$) and -75% (95% CI, -79.7% to -69.3%; $P<.001$) respectively, in the adjusted model (for seasonality and overdispersion). Results for individual NIRVs, including RSV, hMPV, hERV, and PIV also showed statistically significant declines in both the crude and the adjusted models (Table 2). By examining autocorrelation function we found a weak-to-moderate autocorrelation for the above viruses, mostly at lags 1 to 4; however, computed Newey-West standard errors and corresponding CIs to correct for autocorrelation did not change the direction or statistical significance of the models' predictions for most viruses (autocorrelograms and partial autocorrelograms are provided in Supplemental Figures 4 and 5, available online at http://www.mayoclinicproceedings.org). We observed significant change in the

TABLE 1. Summary Statistics on Test Positivity Rates of Influenza and Noninfluenza Respiratory Viruses Before and After the Initiation of COVID-19 Pandemic Public Health Interventions at Week 11, 2020[a]

Viruses under surveillance[b]	Prepandemic period and before COVID-19 public health interventions (n=148 weeks)		After initiation of COVID-19 public health interventions (n=20 weeks)	
	Mean weekly test positivity (SD)	Mean weekly positive test count (SD)	Mean weekly test positivity (SD)	Mean weekly positive test count (SD)
Influenza (A/B)	0.119 (0.113)	121.7 (159.7)	0.011 (0.031)	39.45 (113.7)
RSV	0.051 (0.057)	49.53 (61.80)	0.006 (0.011)	22.55 (41.69)
hCoVs	0.028 (0.032)	26.83 (33.46)	0.013 (0.021)	48.9 (73.46)
hMPV	0.039 (0.035)	29.78 (31.21)	0.012 (0.019)	43.25 (66.24)
hERV	0.195 (0.097)	112.04 (42.41)	0.041 (0.030)	157.5 (106.8)
PIV	0.047 (0.027)	31.19 (19.42)	0.003 (0.006)	12.65 (20.48)
All NIRVs	0.397 (0.081)	273.7 (136.7)	0.086 (0.091)	327.2 (324.8)

[a]COVID-19, coronavirus disease 2019; hCoV, human coronavirus; hERV, human enteroviruses/rhinoviruses; hMPV, human metapneumoviruses; NIRV, noninfluenza respiratory viruses; PIV, parainfluenza viruses; RSV, respiratory syncytial virus.

[b]Influenza viruses include A/H1, A/H3, and B. hCoVs include HKU1, 229E, OC43, and NL63). PIVs include types 1—4. NIRVs include RSV, hCoV, hMPV, hERV, PIV, and adenovirus. hCoVs do not include SARS-CoV or SARS-CoV-2.

trajectory of the time series of these viruses postintervention compared with counterfactuals preintervention (Figures 2 and 3).

The analyses concerning hCoVs showed mixed results. There was a -67.8% (95% CI, -64.7 to -70.5%; $P<.001$) reduction in the crude model, which was less pronounced when adjusted for seasonality and overdispersion (-22.3%; 95% CI, -1.1 to -39%; $P=.04$), which became statistically nonsignificant after autocorrelation adjustment (95% CI, -49.3% to 19.0%; $P=.25$) (Table 2 and Figure 3B).

To evaluate the effect of patient age, the IRRs of TPR changes were compared between age groups 0—5 and 0—16 years (Supplemental Tables 1 and 2, available online at http://www.mayoclinicproceedings. org). Comparison of these two age groups showed a nonsignificant reduction in hCoVs (as seen with all ages) (Table 2) and hMPV (not seen among all ages). Based on this, age was not an influencing factor, but rather an effect modifier, in the reduction of respiratory virus activity (influenza and NIRVs) observed postintervention.

DISCUSSION

Using our population-based surveillance data, we are able to show that the TPRs of influenza and NIRVs rapidly declined during the COVID-19 pandemic and was temporally

associated with the initiation of public health measures including physical distancing and isolation of symptomatic individuals. These findings suggest that interventions addressing the common transmission routes of droplets and close contact could curb the transmission of COVID-19 as well as influenza and other respiratory viruses. The contribution of viral competition or interference between SARS-CoV-2 and other endemic circulating respiratory viruses has not been yet determined.[33]

Our results are consistent with reports on the reduced incidence of influenza reported in the United States, Japan, Australia, China, South Korea, Taiwan, and Hong Kong (showing a 44% to 64% reduction).[13,16,18,20,34-38] Initiation of public health measures had been reported to result in reduction of influenza during the SARS-CoV epidemic in Hong Kong in 2003.[39] Nonpharmacological interventions including physical distancing, isolation of symptomatic individuals, contact tracing, school closures, and use of face masks have been shown to be moderately effective for control of influenza epidemics and pandemics.[20] Our study adds that the burden of NIRVs was also significantly reduced, and that initiation of public health interventions is temporally correlated with their abrupt decline, suggesting effectiveness. At the time of writing,

TABLE 2. IRRs and CIs of the Change in the Test Positivity Rates for Influenza and Noninfluenza Respiratory Viruses Before and After the Initiation of COVID-19 Pandemic Public Health Interventions at Week 11, 2020[a,b]

| Viruses under surveillance[c] | Crude models | | | Adjusted models | | | | |
| | | | | For overdispersion and seasonality | | | For seasonality and autocorrelation[d] | |
	IRR	95% CI	P	IRR	95% CI	P	95% CI	P
Influenza (A/B)	0.057	0.053-0.062	<0.001	0.138	0.085-0.226	<.001	0.093-0.205	<.001
RSV	0.064	0.058-0.071	<0.001	0.163	0.122-0.218	<.001	0.112-0.238	<.001
hCoV	0.322	0.295-0.353	<0.001	0.777	0.610-0.989	.04	0.507-1.19	.246
hMPV	0.384	0.349-0.422	<0.001	0.420	0.306-0.576	<.001	0.348-0.507	<.001
hERV	0.303	0.289-0.318	<0.001	0.249	0.196-0.317	<.001	0.179-0.347	<.001
PIV	0.085	0.074-0.097	<0.001	0.048	0.030-0.078	<.001	0.032-0.072	<.001
All NIRVs	0.235	0.227-0.242	<0.001	0.250	0.203-0.307	<.001	0.181-0.344	<.001

[a]COVID-19, coronavirus disease 2019; hCoV, human coronavirus; hERV, human enteroviruses/rhinoviruses; hMPV, human metapneumoviruses; IRR, incidence rate ratio; NIRV, noninfluenza respiratory viruses; PIV, parainfluenza viruses; RSV, respiratory syncytial virus.

[b]IRR refers to the change in the test positivity rate for each virus in relation to the time of the intervention.

[c]Influenza viruses include A/H1, A/H3, and B. hCoVs include HKU1, 229E, OC43, and NL63. PIVs include types 1—4. NIRVs include RSV, hCoV, hMPV, hERV, PIV, and adenovirus. hCoVs do not include SARS-CoV or SARS-CoV-2.

[d]Adjustment for autocorrelation was performed by computing Newey-West standard errors (and corresponding 95% CIs) on seasonally adjusted models.

Australia also reports decrease in NIRV positivity rates which coincided with the implementation of COVID-19 control measures; with 10-fold or greater reductions in incidence of influenza, rhinovirus, RSV, and PIV.[34] Further study is required to evaluate the effectiveness and relative importance of these nonpharmacological interventions to mitigate influenza and NIRV epidemics, and if any potential rebound effects (eg, viral outbreaks) post lifting of stringent public health measures may occur, which has been described with RSV, hCoVs, and PIV.[40,41] Nevertheless, our findings, together with data elsewhere, strongly suggest that if public health
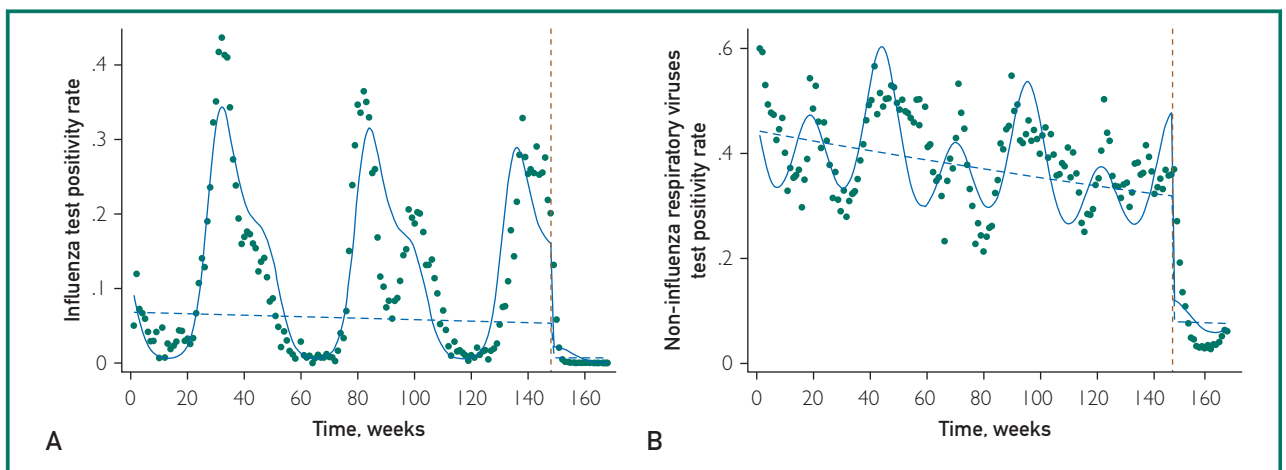

FIGURE 2. Scatterplot and model-predicted test positivity rates (2017—2020) for (A) influenza and (B) noninfluenza respiratory viruses before and after the initiation of coronavirus disease 2019 pandemic public health interventions at week 11, 2020 (indicated by week 149 on the x-axis in the graphs A and B). Green dots inidcate weekly test positivity rate. Solid blue line indicates model-predicted test positivity rate, adjusted for overdispersion and seasonality. Dashed blue line indicates de-seasonalized trend line of test positivity rate. Significant change was noted after week 11, 2020 (week 149 on x-axis; indicated by the vertical dotted line).
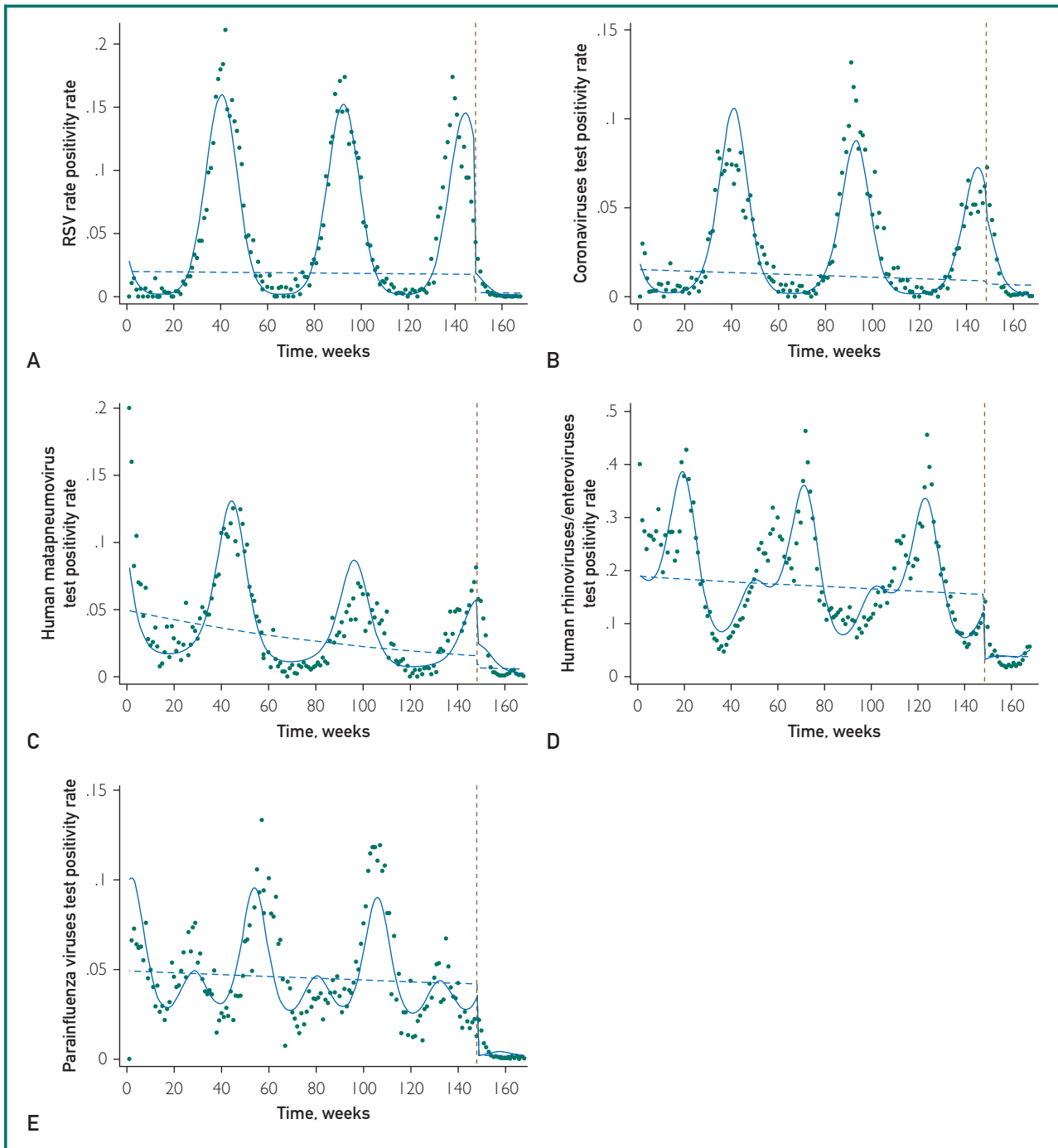
FIGURE 3. Scatterplot and model-predicted test positivity rates for (A) respiratory syncytial virus (RSV), (B) human coronaviruses, (C) human metapneumovirus, (D) human rhinoviruses/enteroviruses, (E) parainfluenza viruses before and after the initiation of coronavirus disease 2019 pandemic public health interventions at week 11, 2020 (indicated by week 149 [vertical dotted line] on the x-axis in graphs A-E). Green dots indicate weekly test positivity rate. Solid blue line indicates model-predicted test positivity rate, adjusted for overdispersion and seasonality. Dashed blue line indicates de-seasonalized trend line of test positivity rate. Except for human coronaviruses, significant change was noted after week 11, 2020 (week 149 on x-axis; indicated by the vertical dotted line).

measures were continued, the burden of other respiratory viral infections could be reduced, thus lowering the impacts on health care systems and public health. If adherence to public health measures is suboptimal or such measures are rolled back, then an increase in SARS-CoV-2 and other respiratory viruses would be expected. Importantly, our data do not undermine the need for influenza vaccination, which is an effective means to reduce disease burden and hospitalizations.[42]

Interestingly, we did not find a significant reduction of hCoVs in the postintervention period as for other NRIVs. There is a paucity of data on hCoVs transmission; recent studies support the respiratory droplets and contact routes, with efficient transmission within households, and community activities generally following a seasonal pattern.[43,44] Our finding of low-level hCoV circulation, despite significant reductions of influenza and other NIRVs, has also been noted from NIRV surveillance data from other countries (Canada, United States, and Switzerland, for example).[45-47] From US and Swiss surveillance data, the most common hCoV subtypes seen during the COVID-19 pandemic include hCoV-NL63 and hCoV-OC43. The explanation for their low-level cocirculation with the pandemic virus despite public health measures is unclear, and further studies on their transmission characteristics (eg, asymptomatic or presymptomatic transmission, as described for SARS-CoV-2), ecological fitness, and potential virus-virus interactions are required.[44]

The strengths of our study include the large number of testing observations contributing to a robust data set. As data regarding all respiratory virus testing are collected via a provincial population-based surveillance program, the data set encompasses results across all ages (including children) as well as both ambulatory and hospital-based settings. All influenza and NIRV infections were laboratory-confirmed. Our multiplex PCR assay did not differentiate between rhinoviruses and enteroviruses; however, enterovirus circulation was likely very low

during the postintervention period (winter/spring months in Alberta) with multiple jurisdictions having identified most pandemic circulating hERVs to be rhinovirus.[17,48] The clearly defined initiation date of interventions in Alberta allowed the use of ITS to examine temporal correlations, and potential confounders including seasonality and overdispersion were carefully adjusted in our models. We consider it unlikely that the increase in respiratory virus testing during the pandemic had resulted in lower positivity rates, as test opportunities are also increased for individuals with mild influenza-like illness who prior to the pandemic may not have sought testing right away and monitored for self-improvement before seeking medical attention. Further, the impact of the volume of tests had been adjusted by comparing the TPR rather than the number of positive detections. The reduction in TPRs observed before and after the interventions are unlikely the result of qualitatively different populations being tested. Firstly, this is justified by the fact that respiratory virus testing was performed on symptomatic individuals only. Secondly, the age stratification evaluation (comparison of IRRs and incidence rates in those aged 0−5 years, 0−16 years, and all ages) did not show paradoxical changes in respiratory virus categories. Thirdly, if influenza and/or NIRVs transmission rates held the same, the TPR for other viruses would have increased rather than decreased, which is the opposite of what was observed. Thus, it is likely that the intervention was successful at decreasing transmission of NIRVs as well.

Our study is limited by its observational nature and because interventions were bundled, thus the contribution of each individual measure (eg, social distancing, self-quarantine, increased hand hygiene, and use of masks) and changes in population behaviors cannot be discerned. The effect observed because of the intervention is suggestive of a correlation rather than direct causation, as not all variables could be controlled. The model used in this study did not adjust for viral coinfections (found

to be very low, approximately 3%),[49] as well as the effect of influenza vaccination. In Alberta, influenza vaccination coverage was constant, at approximately 30% over the study period, and the annual effectiveness was largely comparable for these years.[50,51] Our study period did not include the time from August 2020, at which universal masking was mandated in the two most populous cities in our province, Edmonton, and Calgary, which, combined, comprise approximately 50% of the province's population.[3] The role of travel restrictions was not specifically evaluated; however, there were federal/national advisories in place to avoid nonessential travel and self–14-day quarantine postinternational travel.[52] Although there is no specific data regarding adherence to public health measures during the first wave in Alberta, a review by the Canadian Public Health Association emphasized that Canada was successful in flattening the curve of the first wave of the COVID-19 pandemic.[53]

CONCLUSION

In summary, implementation of public health interventions to mitigate the impact of COVID-19 was found to be associated with a substantial reduction in influenza and NIRV infections in Alberta. Our data suggest that if pandemic public health measures were continued into the winter seasons, the burden of other respiratory viral infections could also be reduced should health care systems become overwhelmed (eg, intensive care units become overwhelmed, need to cancel elective surgical procedures, health care worker re-assignment to manage surge volumes, etc). As less restrictive public health measures are occurring in Canada and elsewhere, continuous surveillance to monitor for increase in transmission of these viruses is needed.[41]

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at http://www.mayoclinicproceedings.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

Abbreviations and Acronyms: hCoV, human coronavirus; **hERV,** human entero/rhinovirus; **hMPV,** human metapneumovirus; **IRR,** incident rate ratio; **ITS,** interrupted time series; **NIRV,** noninfluenza respiratory virus; **PCR,** polymerase chain reaction; **PIV,** parainfluenza virus; **RSV,** respiratory syncytial virus; **TPR,** test positivity rate

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