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# Trends in Pediatric Viral Symptoms, Influenza Testing, and SARS-CoV-2 Testing From a Statewide Electronic Health Record Consortium, January 2017 to July 2021

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## ABSTRACT

**OBJECTIVE:** The heterogeneous implementation and uptake of nonpharmaceutical interventions (NPIs) during the coronavirus disease 2019 (COVID-19) pandemic amplified the need for locally responsive disease surveillance mechanisms. Using data from a newly developed statewide electronic health record (EHR) consortium in Minnesota, we sought to characterize trends in pediatric viral symptoms, influenza testing, and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing.

**METHODS:** We conducted a serial cross-sectional analysis of EHR data from 1/1/2017 to 7/30/2021 across 8 large health systems in Minnesota. We included patients  $\leq 18$  years of age with any SARS-CoV-2 test, influenza test, or documented diagnostic code which met our viral symptom definition. We plotted week-by-week trends in viral symptoms, SARS-CoV-2 and influenza testing, and test positivity, stratified between children (0–11 years) and adolescents (12–18 years).

**RESULTS:** We identified 1,079,924 patients  $\leq 18$  years of age with viral symptoms or testing; 880,669 (81.5%) were children  $\leq 11$  years. Influenza testing and influenza test

positivity remained well below historical averages from March 2020 through mid-May 2021. Peaks in viral symptoms during this time were concomitant with peaks in SARS-CoV-2 testing and test positivity, whereas influenza testing and test positivity remained stagnant. Influenza test positivity rates increased substantively among children from May through July 2021.

**CONCLUSIONS:** Viral illness and influenza testing among pediatric patients were below historical averages throughout the COVID-19 pandemic. Ongoing increases in influenza test positivity may merit clinical and public health awareness and intervention. Future NPI policies can be better targeted with insights from collaborative EHR-based surveillance, which enhances real-time, locally sensitive measurement of disease outbreaks.

**KEYWORDS:** coronavirus disease 2019; electronic health record; health informatics; influenza; public health; systemic acute respiratory syndrome coronavirus 2; viral surveillance

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## WHAT’S NEW

We aggregated electronic health record data across Minnesota’s largest health systems to surveil outbreaks and inform public health interventions. Viral illness and influenza testing were below historical averages throughout the COVID-19 pandemic. Influenza test positivity among children increased from May through July 2021.

NONPHARMACEUTICAL INTERVENTIONS (NPIs) such as face masks, social distancing, and school closures have been a hallmark of policy responses to the coronavirus disease 2019 (COVID-19) pandemic. Studies from early interventions in the United States and abroad revealed spillover impacts of NPIs on reducing non-COVID-19 infectious disease incidence and related health care utilization among pediatric patients.<sup>1–9</sup> In the United States,

the implementation and uptake of NPIs varied widely between states, age groups, and time periods, demonstrating a persistent need for locally targeted public health monitoring and policy response mechanisms.<sup>10–12</sup>

Electronic health records (EHRs) are a promising tool for public health surveillance,<sup>13–15</sup> but the vast majority of public health agencies in the United States are not readily able to access the breadth or depth of EHR data.<sup>15</sup> In March 2020, the Minnesota EHR Consortium (hereafter “the Consortium”) was created by Minnesota’s largest health systems, statewide health care organizations with expertise in systems-level collaboration and public health measurement, and the Minnesota Department of Health. While our original intent was to rigorously characterize chronic disease epidemiology across the state, the COVID-19 pandemic rapidly expanded this collaboration to establish an EHR-based syndromic surveillance system and inform state public health responses.<sup>16,17</sup>

We sought to characterize the incidence of respiratory viral symptoms among pediatric patients during winter months when surges in respiratory viral infections would otherwise be expected. We leveraged surveillance data from the Consortium to compare week-by-week historical and current trends in pediatric viral symptoms, influenza testing and test positivity, and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing and test positivity.

## METHODS

We conducted a serial cross-sectional study using EHR data from January 1, 2017 through July 30, 2021 reported to the Consortium, which aggregates deidentified summary data from nine of the largest health systems in Minnesota, including all major pediatric hospitals. Approximately 90% of Minnesotans across all ages have been seen at one of the participating health systems, and approximately 70% of Minnesotan children receive routine care at a Consortium site. We included patients  $\leq 18$  years of age seen at any health care facility reporting data to the Consortium across all encounter types (ie, telehealth, outpatient, emergency department, inpatient). We defined cohort eligibility criteria as patients with any SARS-CoV-2 test, any influenza test, and/or symptoms meeting our “viral symptoms” definition, based on the presence of one or more relevant *International Classification of Disease, 10th Revision, Clinical Modification* (ICD-10-CM) code(s) listed in [Appendix 1](#). Our broad definition of viral symptoms was developed in March 2020 by Consortium site investigators based on a modification to the US Centers for Disease Control and Prevention case definition for surveillance of influenza-like illness, with additional ICD-10 codes to capture pertinent COVID-19 symptoms. Our viral symptom definition was not intended to estimate the absolute prevalence of viral illness in the community, but rather, aimed to surveil the relative prevalence and shifting trends in viral symptoms across seasons and between years. Each site submitted weekly data for centralized aggregation and reporting on

Friday of each Centers for Disease Control and Prevention *MMWR* week, a standardized epidemiologic date system for which disease incidence is reported to the National Notifiable Diseases Surveillance System.<sup>18</sup>

We plotted week-by-week trends in viral symptoms, influenza testing and positivity, and SARS-CoV-2 testing and positivity using RStudio, version 1.3.1073 (R Foundation for Statistical Computing, Vienna, Austria). We labelled each plot with key NPI dates obtained from the COVID-19 US State Policy Database.<sup>19</sup> We stratified trends by age between children (0–11 years) and adolescents (12–18 years). This study was approved or deemed exempt by institutional review boards at each participating site.

## RESULTS

We identified 1,079,924 patients ages 0 to 18 with viral symptoms over the course of our study period; 880,669 (81.5%) were 0 to 11 years of age. Viral symptom prevalence in early 2020 surpassed historical averages but declined sharply in both children and adolescents starting in March 2020 (*MMWR* week 11), shortly after the national COVID-19 emergency declaration on March 1, 2020 (week 10) and statewide NPI implementation (week 13) ([Fig. 1](#)). Viral symptoms among children remained near or below historical averages throughout the winter, other than 2 small peaks in fall 2020 (weeks 40 and 45). Viral symptoms among adolescents surpassed historical averages from March 2020 (week 11) onwards, peaked in both July and November 2020 (weeks 30 and 45), subsequently declined from mid-November 2020 through February 2021 (week 7). Among both children and adolescents, viral symptoms surpassed historical averages with peaks in late April 2021 (week 16), and among children remained at or above historical averages through the end of July 2021 (week 30).

Similar to viral symptom trends, rates of influenza testing and positive results in early 2020 surpassed historical trends ([Fig. 2](#)). Positive tests peaked by week 8, and subsequently declined more steeply than historical averages with the greatest negative slope between weeks 11–14 ([Fig. 2C and D](#)). By March 2020 (week 12), influenza testing also began decreasing in both age categories ([Fig. 2A and B](#)). Testing and positive tests remained at or below historical trends from November 2020 (week 44) through the end of the study period. Influenza test positivity from March 2020 (week 10) to May 2021 (week 18) consistently remained well below historical averages (range 0.0%–3.5%) and did not surpass 3% after week 41 ([Fig. 3](#)). However, among children, influenza test positivity has trended upwards since May 2021 (week 20), eclipsed historical trends by mid-June (week 23), and peaked at  $\sim 35\%$  at the end of the study period (week 30) ([Figs. 2A and 3A](#)).

SARS-CoV-2 testing and positive results surpassed historical and concurrent influenza testing around May 2020 (weeks 18–19), and testing rates generally remained near or above historical and concurrent influenza testing

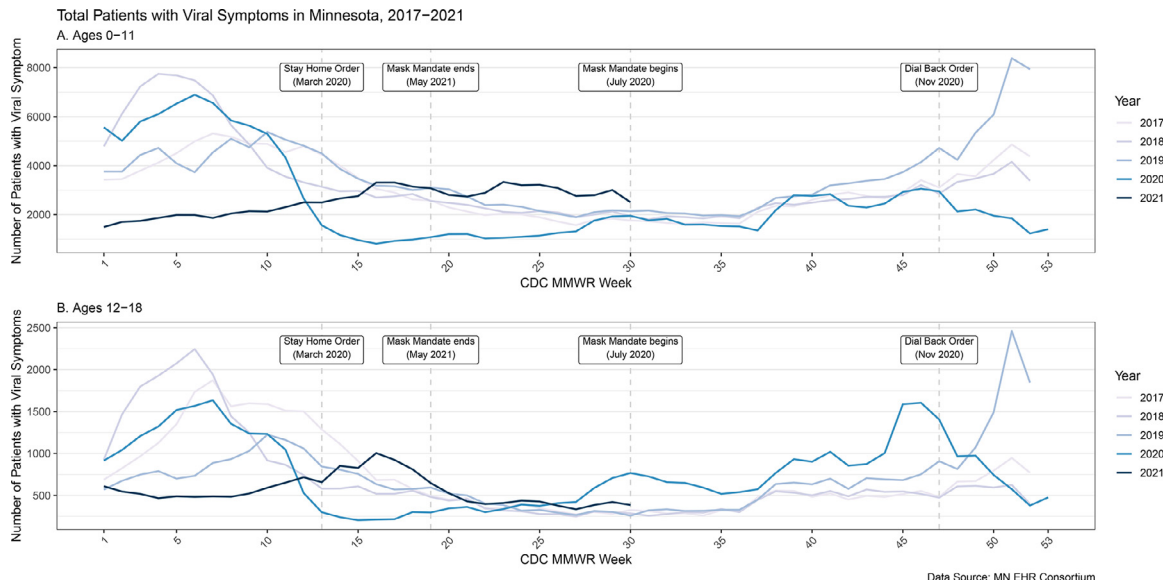


Figure 1. Week-by-week trends in the number of patients with viral symptoms in Minnesota (A) 0 to 11 and (B) 12 to 18 years of age.

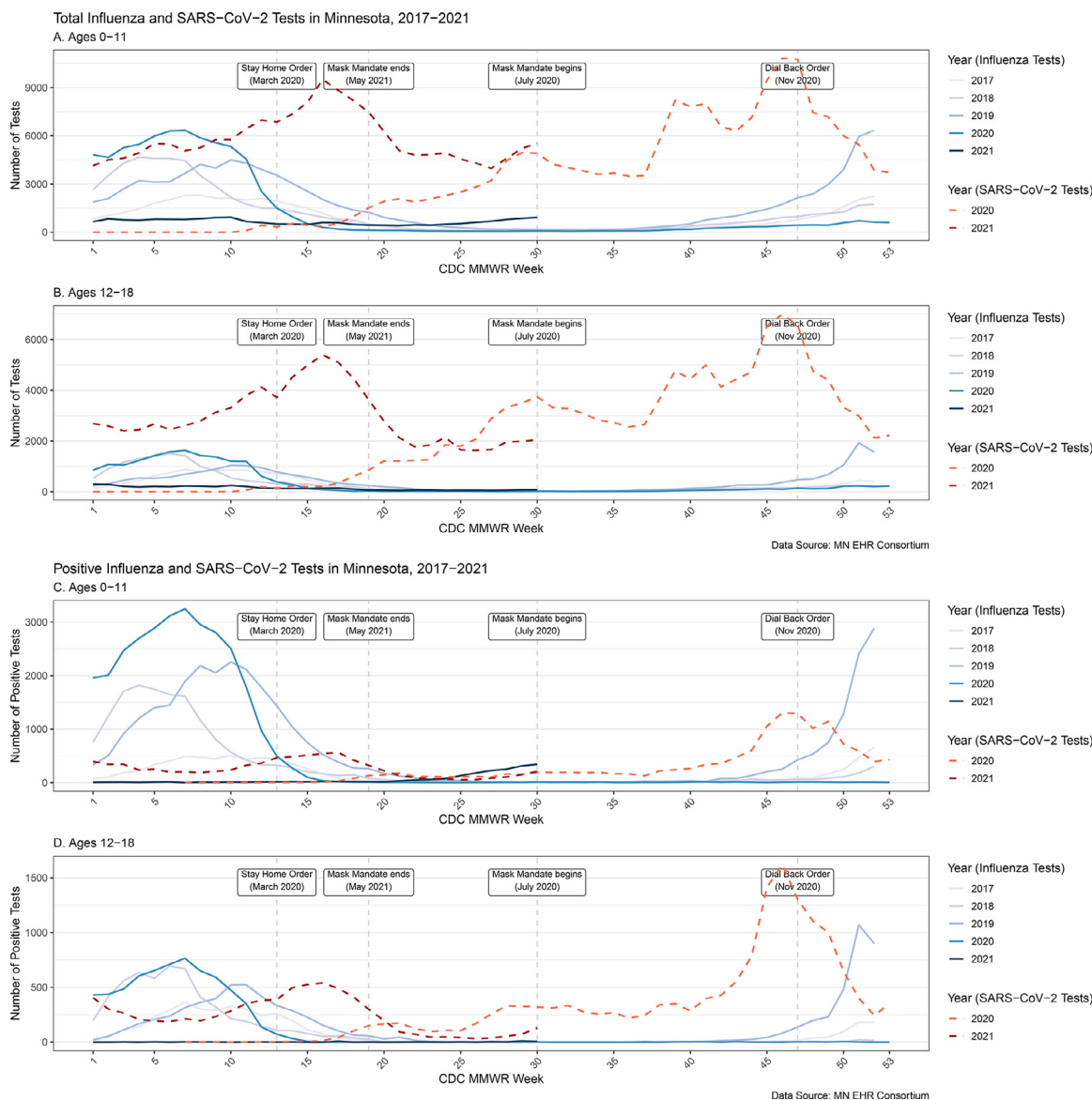
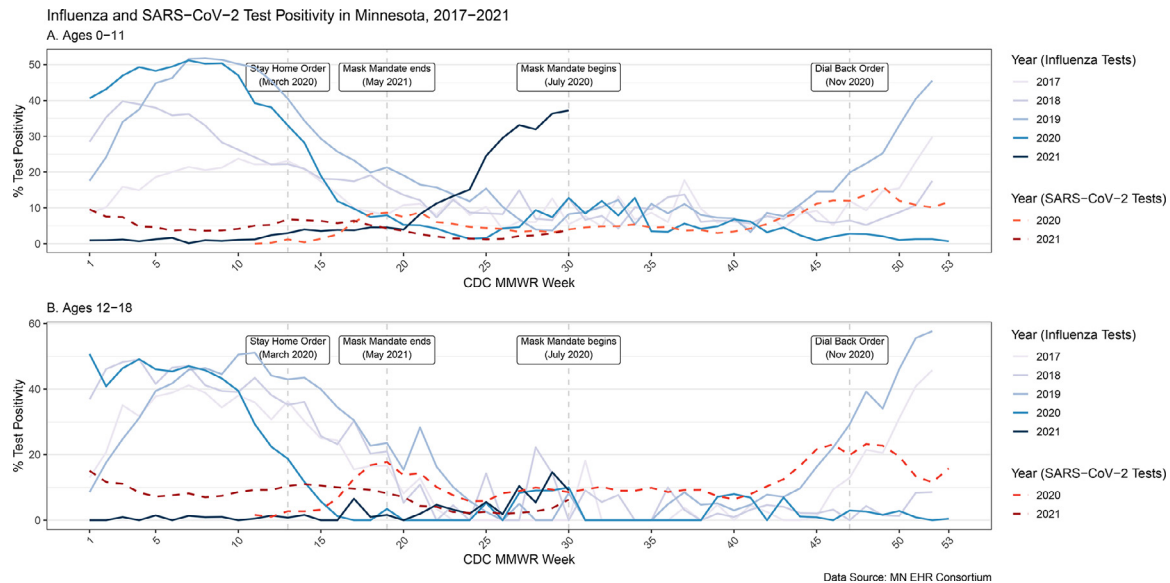


Figure 2. Week-by-week trends in the number of total and positive influenza and SARS-CoV-2 tests among patients in Minnesota (A and C) 0 to 11 and (B and D) 12 to 18 years of age. SARS-CoV-2 indicates severe acute respiratory syndrome coronavirus 2.



**Figure 3.** Week-by-week trends in influenza and SARS-CoV-2 percent test positivity among patients in Minnesota age (A) 0 to 11 and (B) 12 to 18 years of age. SARS-CoV-2 indicates severe acute respiratory syndrome coronavirus 2.

through the end of the study period (Fig. 2). Periods of increased SARS-CoV-2 testing, positive tests, and percent test positivity mirrored simultaneous peaks in viral symptoms, particularly among adolescent patients (Figs. 2 and 3).

## DISCUSSION

Using an EHR-based approach to statewide pediatric syndromic surveillance, we tracked dramatic declines in influenza testing, positive results, and percent influenza test positivity among children and adolescents in Minnesota from the national emergency declaration and statewide introduction of NPIs (stay at home orders, business closures, activity restrictions, and indoor masking recommendations) in March 2020 through mid-May 2021.<sup>10</sup> We also noted concomitant peaks in SARS-CoV-2 testing, positive tests, percent test positivity, and presentation with viral symptoms throughout fall 2020 while influenza testing remained stagnant, particularly among adolescent patients. SARS-CoV-2 testing and positive tests slightly declined after introduction of an indoor mask mandate in June 2020, and substantively declined after the “Dial Back Minnesota” executive order in November 2020, which closed in-person dining and gyms, prohibited youth sports, and recommended against in-person gatherings. Last, we identified an ongoing uptick in influenza test positivity among children from May through July 2021, though testing rates remain well below historical peaks.

Overall, our findings reinforce previous studies of health care utilization,<sup>2,4,5</sup> influenza testing,<sup>3,8</sup> and non-COVID-19 viral symptoms<sup>1,2</sup> among pediatric patients in the United States, with additional findings that trends from late 2020 have generally continued through July 2021. Changes in the incidence of viral symptoms and positive tests may reflect changes in both disease

incidence and care-seeking behavior. However, given that rising positive tests and positivity rates correlate with periods of rising viral symptoms, the trends identified in this study are more likely representative changes in disease incidence. The increased influenza test positivity towards the end of our study period reaffirms the possibility of a Northern Hemisphere influenza resurgence, analogous to the documented resurgence of influenza in tropical Asia and respiratory syncytial virus in Australia and the United States after relaxation of COVID-19-related NPIs.<sup>9,20,21</sup>

Key strengths of our statewide study include the ability to simultaneously surveil viral symptoms and corresponding test results, the integration of data from all encounter locations and levels of care across 9 large health systems, and the demonstrated feasibility of a rapidly scaled multi-system partnership in addressing a pressing public health surveillance need. Moreover, in reflecting upon the Consortium’s broader work throughout the pandemic and looking towards the post-COVID-19 future, our successful linkage of EHR data across multiple health systems has become a powerful data source for surveillance of other public health priorities,<sup>13,15</sup> an opportunity for cross-sector linkages with social services, housing, and criminal justice agencies,<sup>22</sup> and a mechanism to tie disease outcomes and population health metrics with place-based vulnerability indices.<sup>14,23</sup>

Our study also has limitations. First, we only included patients seeking care at participating health systems; thus, we may underestimate true prevalence rates since patients with milder symptoms may not have sought care. Second, we did not examine pathogen-specific testing outcomes for other respiratory viruses; trends may differ depending on the seasonality and environmental parameters of other pathogens.<sup>9,24</sup> Finally, trends observed in Minnesota may be generalizable to states or regions with similar demographic and political composition, but our findings should



be interpreted in the context of regional disease spread, local and state policies, NPI implementation and uptake, and environmental conditions.

In the wake of a potential impending resurgence in respiratory viral infections which may not reflect typical seasonality, clinicians should maintain an increased index of suspicion to test for non-SARS-CoV-2 respiratory pathogens and encourage influenza vaccination for eligible individuals aged  $\geq 6$  months, and public health officials should reinforce everyday preventive measures as schools and workplaces reopen.<sup>9</sup> Our findings may also have implications for future consideration of NPIs to mitigate spread of seasonal viral illnesses among pediatric patients.<sup>25</sup> Overall, our work highlights how statewide NPI policies could be better targeted and monitored with insights from collaborative EHR-based surveillance, which enhances real-time measurement of transmissible disease outbreaks.

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## SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at <https://doi.org/10.1016/j.acap.2021.08.008>.

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