Monitoring Report: Respiratory Viruses

Truveta Research

July 28, 2023

Intended Audience: This technical report is intended for scientific audiences.

About this report

This report contains current hospitalization trends associated with six common respiratory viruses: COVID-19, human metapneumovirus (HMPV), influenza, parainfluenza virus, respiratory syncytial virus (RSV), and rhinovirus. We used a subset of Truveta Data to identify laboratory-confirmed infections associated with these respiratory viruses in children and adults. Truveta was formed and governed by US health systems with a shared vision of saving lives with data. Truveta's 31 members provide 18% of patient care in the United States in more than 20,000 clinics and 800 hospitals. Updated data are provided daily to Truveta. The subset of Truveta Data used in this study was provided on July 21, 2023 and included de-identified patient care data primarily located across ten states: New York, California, Texas, Washington, Illinois, North Carolina, Oregon, Wisconsin, Alaska, and Montana.

The figures below are intended to describe trends and comparisons of respiratory virus-associated hospitalizations in different demographic groups and across seasons. For the purposes of this report seasons are defined as the period from October through September of the following year. Given the unadjusted nature of the data, the rates do not account for undertesting and other variability that exist across patient groups, providers, and systems. For further limitations, see the section below.

Importance of this report

This report is intended to monitor the temporal patterns of key respiratory viruses in the United States. COVID, influenza, and RSV account for a large proportion of hospitalizations related to respiratory illnesses. To provide a more complete understanding of hospitalizations related to respiratory viruses, we have also included other viruses known to cause respiratory illness such as human metapneumovirus (HMPV), parainfluenza, and rhinovirus. Each of these viruses can lead to hospitalization and death especially in vulnerable populations, such as infants, children, and older

adults (Pastula et al., 2017; Shi et al., 2017, Centers for Disease Control and Prevention 2023a, Smits et al., 2023). Representative and timely data to proactively monitor infections are scarce.

It is important for public health experts and clinical providers to understand the trends in these infections to inform decisions about public health, clinical care, and public policy. Connecting population-level trends with granular clinical information available in Truveta Studio can be very useful to more deeply understand which cohorts are most impacted.

This report is intended to supplement the surveillance data provided by the CDC (Centers for Disease Control and Prevention, 2023b). This report includes additional independent data and clinical detail that is not captured in other reports.

Data

Respiratory virus case definition

A case is defined by laboratory-confirmed respiratory virus infection (COVID, HMPV, influenza, parainfluenza virus, RSV, or rhinovirus) in a person who:

1. Was hospitalized in a Truveta-associated health system and
2. Tested positive for the respiratory virus 14 days before or after the start of the hospitalization

For the purposes of this report test positivity is defined as a positive value for any LOINC code listed in table S1 for COVID, table S2 for HMPV, table S3 for influenza, table S4 for parainfluenza virus, table S5 for RSV, or table S6 for rhinovirus.

Data acquisition

Our study included hospitalized patients who tested positive for one of the selected respiratory viruses within 14 days before or during the hospitalization from October 01, 2018 to June 30, 2023 in Truveta Data.

Every respiratory virus-associated hospitalization has been grouped such that every hospitalization within 90 days is considered to be the same infection and thus only counted once.

Analysis

Overall population

Our study population consists of 247,420 hospitalizations of 231,654 unique patients from October 2018 – June 2023. To align with seasonality in respiratory transmission, time periods include October 1st through September 30th of the following year. The demographics of patients are as follows:

Table 1: Demographics

	2018/2019 (N=20,908)	2019/2020 (N=37,734)	2020/2021 (N=62,661)	2021/2022 (N=66,745)	2022/2023 (N=43,606)	Overall (N=231,654)
Respiratory Virus						
COVID	0 (0%)	22,668 (60.1%)	57,638 (92.0%)	55,942 (83.8%)	24,330 (55.8%)	160,578 (69.3%)
HMPV	1,964 (9.4%)	1,384 (3.7%)	74 (0.1%)	1,263 (1.9%)	2,102 (4.8%)	6,787 (2.9%)
Influenza	6,310 (30.2%)	6,561 (17.4%)	97 (0.2%)	1,664 (2.5%)	6,594 (15.1%)	21,226 (9.2%)
Parainfluenza virus	2,129 (10.2%)	677 (1.8%)	644 (1.0%)	1,131 (1.7%)	1,678 (3.8%)	6,259 (2.7%)
RSV	2,807 (13.4%)	2,348 (6.2%)	745 (1.2%)	2,080 (3.1%)	3,378 (7.7%)	11,358 (4.9%)
Rhinovirus	7,698 (36.8%)	4,096 (10.9%)	3,463 (5.5%)	4,665 (7.0%)	5,524 (12.7%)	25,446 (11.0%)
Age Group						
0 - <6 months	1,224 (5.9%)	907 (2.4%)	662 (1.1%)	1,213 (1.8%)	1,243 (2.9%)	5,249 (2.3%)
6 - <12 months	555 (2.7%)	406 (1.1%)	256 (0.4%)	549 (0.8%)	554 (1.3%)	2,320 (1.0%)
1 - <2 years	802 (3.8%)	516 (1.4%)	469 (0.7%)	883 (1.3%)	802 (1.8%)	3,472 (1.5%)
2 - 4 years	1,009 (4.8%)	648 (1.7%)	539 (0.9%)	1,313 (2.0%)	1,338 (3.1%)	4,847 (2.1%)
5 - 17 years	936 (4.5%)	709 (1.9%)	1,021 (1.6%)	1,618 (2.4%)	1,499 (3.4%)	5,783 (2.5%)
18 - 49 years	2,658 (12.7%)	8,206 (21.7%)	15,529 (24.8%)	14,460 (21.7%)	6,132 (14.1%)	46,985 (20.3%)

	2018/2019 (N=20,908)	2019/2020 (N=37,734)	2020/2021 (N=62,661)	2021/2022 (N=66,745)	2022/2023 (N=43,606)	Overall (N=231,654)
50 - 64 years	3,866 (18.5%)	9,270 (24.6%)	15,762 (25.2%)	13,130 (19.7%)	6,698 (15.4%)	48,726 (21.0%)
65 - 74 years	3,624 (17.3%)	7,088 (18.8%)	12,310 (19.6%)	12,717 (19.1%)	8,424 (19.3%)	44,163 (19.1%)
75 - 85 years	3,675 (17.6%)	6,127 (16.2%)	10,122 (16.2%)	12,559 (18.8%)	9,725 (22.3%)	42,208 (18.2%)
85+ years	2,559 (12.2%)	3,857 (10.2%)	5,991 (9.6%)	8,303 (12.4%)	7,191 (16.5%)	27,901 (12.0%)
Sex						
Female	11,092 (53.1%)	18,914 (50.1%)	30,653 (48.9%)	34,399 (51.5%)	23,001 (52.7%)	118,059 (51.0%)
Male	9,810 (46.9%)	18,774 (49.8%)	31,901 (50.9%)	32,292 (48.4%)	20,568 (47.2%)	113,345 (48.9%)
Unknown	6 (0.0%)	46 (0.1%)	107 (0.2%)	54 (0.1%)	37 (0.1%)	250 (0.1%)
Race						
White	14,446 (69.1%)	22,666 (60.1%)	41,948 (66.9%)	46,421 (69.5%)	30,148 (69.1%)	155,629 (67.2%)
Black or African American	2,350 (11.2%)	5,732 (15.2%)	7,087 (11.3%)	7,550 (11.3%)	4,525 (10.4%)	27,244 (11.8%)
Asian	966 (4.6%)	1,905 (5.0%)	2,643 (4.2%)	2,688 (4.0%)	2,182 (5.0%)	10,384 (4.5%)
American Indian or Alaska Native	172 (0.8%)	238 (0.6%)	425 (0.7%)	577 (0.9%)	382 (0.9%)	1,794 (0.8%)
Native Hawaiian or Other Pacific Islander	94 (0.4%)	206 (0.5%)	284 (0.5%)	274 (0.4%)	168 (0.4%)	1,026 (0.4%)
Other Race	2,107 (10.1%)	5,302 (14.1%)	8,002 (12.8%)	6,867 (10.3%)	4,171 (9.6%)	26,449 (11.4%)
Declined to answer	108 (0.5%)	231 (0.6%)	347 (0.6%)	362 (0.5%)	253 (0.6%)	1,301 (0.6%)
Unknown	665 (3.2%)	1,454 (3.9%)	1,925 (3.1%)	2,006 (3.0%)	1,777 (4.1%)	7,827 (3.4%)
Ethnicity						
Hispanic or Latino	2,357 (11.3%)	8,106 (21.5%)	12,885 (20.6%)	9,527 (14.3%)	5,288 (12.1%)	38,163 (16.5%)

	2018/2019 (N=20,908)	2019/2020 (N=37,734)	2020/2021 (N=62,661)	2021/2022 (N=66,745)	2022/2023 (N=43,606)	Overall (N=231,654)
Not Hispanic or Latino	16,173 (77.4%)	25,351 (67.2%)	44,001 (70.2%)	52,322 (78.4%)	34,874 (80.0%)	172,721 (74.6%)
Declined to answer	105 (0.5%)	187 (0.5%)	297 (0.5%)	318 (0.5%)	235 (0.5%)	1,142 (0.5%)
Unknown	2,273 (10.9%)	4,090 (10.8%)	5,478 (8.7%)	4,578 (6.9%)	3,209 (7.4%)	19,628 (8.5%)
Comorbidities						
Asthma	2,992 (14.3%)	3,228 (8.6%)	4,185 (6.7%)	6,607 (9.9%)	5,604 (12.9%)	22,616 (9.8%)
Chronic Lung Disease	2,068 (9.9%)	2,247 (6.0%)	3,066 (4.9%)	4,393 (6.6%)	3,563 (8.2%)	15,337 (6.6%)

Time series analysis

The rate of respiratory virus-associated hospitalizations compared to all hospitalizations is shown in figure 1. Patients were included in this calculation on the first day of their hospitalization. If their stay was greater than one day, they were not counted on subsequent dates. Figure 2 shows the same data stacked to represent the combined impact of the viruses.

Figure 1: Rate of weekly respiratory virus-associated hospitalizations compared to all hospital admissions since October 2018

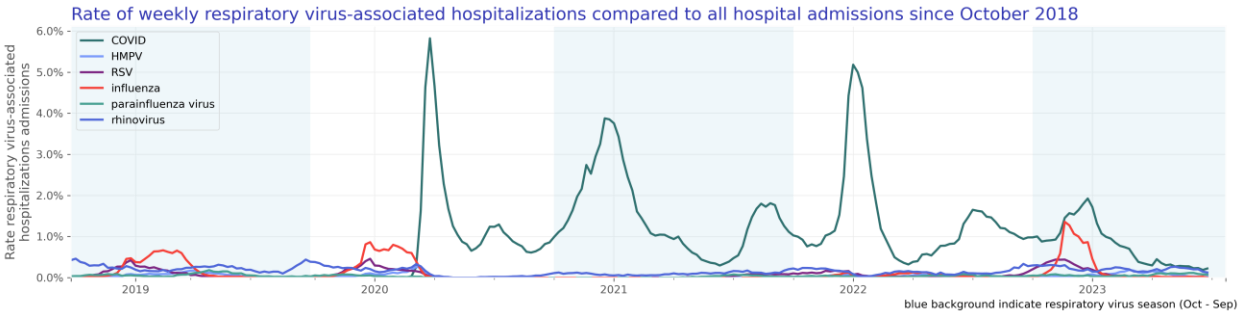
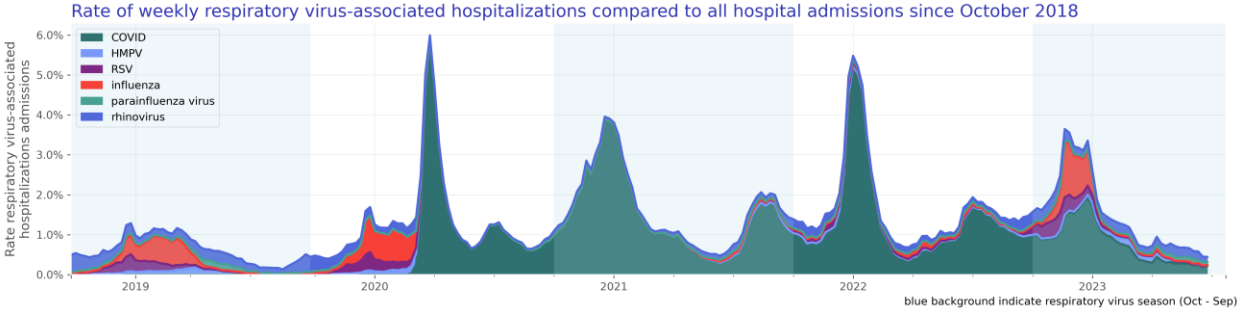


Figure 2: Rate of weekly respiratory virus-associated hospitalizations compared to all hospital admissions since October 2018



COVID-19

Our COVID study population consists of 165,759 hospitalizations of 163,466 unique patients. To align with seasonality in respiratory transmission, time periods include October 1st through September 30th of the following year. The demographics of patients are as follows:

Table 2: COVID Demographics

	2019/2020 (N=22,668)	2020/2021 (N=57,638)	2021/2022 (N=55,942)	2022/2023 (N=24,330)	Overall (N=160,578)
Age Group					
0 - <6 months	42 (0.2%)	188 (0.3%)	369 (0.7%)	133 (0.5%)	732 (0.5%)
6 - <12 months	3 (0.0%)	34 (0.1%)	104 (0.2%)	43 (0.2%)	184 (0.1%)
1 - <2 years	8 (0.0%)	50 (0.1%)	110 (0.2%)	35 (0.1%)	203 (0.1%)
2 - 4 years	11 (0.0%)	59 (0.1%)	173 (0.3%)	54 (0.2%)	297 (0.2%)
5 - 17 years	121 (0.5%)	501 (0.9%)	671 (1.2%)	176 (0.7%)	1,469 (0.9%)
18 - 49 years	5,900 (26.0%)	14,623 (25.4%)	12,956 (23.2%)	3,448 (14.2%)	36,927 (23.0%)
50 - 64 years	6,327 (27.9%)	15,105 (26.2%)	11,668 (20.9%)	3,715 (15.3%)	36,815 (22.9%)
65 - 74 years	4,460 (19.7%)	11,745 (20.4%)	11,236 (20.1%)	5,121 (21.0%)	32,562 (20.3%)
75 - 85 years	3,679 (16.2%)	9,639 (16.7%)	11,232 (20.1%)	6,536 (26.9%)	31,086 (19.4%)

	2019/2020 (N=22,668)	2020/2021 (N=57,638)	2021/2022 (N=55,942)	2022/2023 (N=24,330)	Overall (N=160,578)
85+ years	2,117 (9.3%)	5,694 (9.9%)	7,423 (13.3%)	5,069 (20.8%)	20,303 (12.6%)
Sex					
Female	10,922 (48.2%)	28,089 (48.7%)	28,797 (51.5%)	12,632 (51.9%)	80,440 (50.1%)
Male	11,710 (51.7%)	29,444 (51.1%)	27,094 (48.4%)	11,667 (48.0%)	79,915 (49.8%)
Unknown	36 (0.2%)	105 (0.2%)	51 (0.1%)	31 (0.1%)	223 (0.1%)
Race					
White	12,485 (55.1%)	38,916 (67.5%)	39,600 (70.8%)	17,596 (72.3%)	108,597 (67.6%)
Black or African American	3,871 (17.1%)	6,314 (11.0%)	6,217 (11.1%)	2,318 (9.5%)	18,720 (11.7%)
Asian	1,192 (5.3%)	2,412 (4.2%)	2,075 (3.7%)	1,089 (4.5%)	6,768 (4.2%)
American Indian or Alaska Native	126 (0.6%)	384 (0.7%)	447 (0.8%)	186 (0.8%)	1,143 (0.7%)
Native Hawaiian or Other Pacific Islander	118 (0.5%)	253 (0.4%)	200 (0.4%)	72 (0.3%)	643 (0.4%)
Other Race	3,719 (16.4%)	7,258 (12.6%)	5,535 (9.9%)	2,048 (8.4%)	18,560 (11.6%)
Declined to answer	168 (0.7%)	321 (0.6%)	312 (0.6%)	140 (0.6%)	941 (0.6%)
Unknown	989 (4.4%)	1,780 (3.1%)	1,556 (2.8%)	881 (3.6%)	5,206 (3.2%)
Ethnicity					
Hispanic or Latino	6,080 (26.8%)	12,088 (21.0%)	7,831 (14.0%)	2,483 (10.2%)	28,482 (17.7%)
Not Hispanic or Latino	13,944 (61.5%)	40,194 (69.7%)	43,998 (78.6%)	19,836 (81.5%)	117,972 (73.5%)
Declined to answer	121 (0.5%)	268 (0.5%)	279 (0.5%)	122 (0.5%)	790 (0.5%)
Unknown	2,523 (11.1%)	5,088 (8.8%)	3,834 (6.9%)	1,889 (7.8%)	13,334 (8.3%)
Comorbidities					

	2019/2020 (N=22,668)	2020/2021 (N=57,638)	2021/2022 (N=55,942)	2022/2023 (N=24,330)	Overall (N=160,578)
Asthma	1,168 (5.2%)	3,483 (6.0%)	4,958 (8.9%)	2,497 (10.3%)	12,106 (7.5%)
Chronic Lung Disease	887 (3.9%)	2,761 (4.8%)	3,540 (6.3%)	1,885 (7.7%)	9,073 (5.7%)

Time series analysis

The rate of COVID-associated hospitalization is shown in figure 3. Figure 4 shows seasonal trends.

Figure 3: Rate of weekly COVID-associated hospitalizations compared to all hospital admissions since October 2018

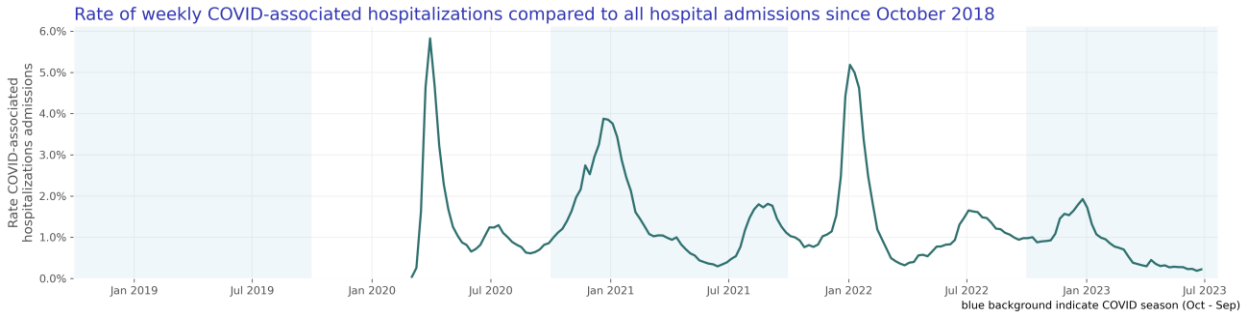
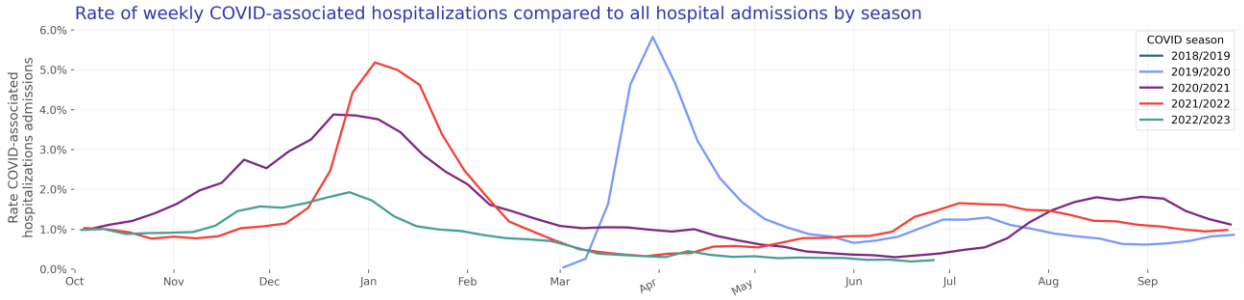


Figure 4: Rate of weekly COVID-associated hospitalizations compared to all hospital admissions by season



Human metapneumovirus (HMPV)

Our HMPV study population consists of 7,605 hospitalizations of 7,592 unique patients.

The demographics of patients are as follows:

Table 3: HMPV Demographics

	2018/2019 (N=1,964)	2019/2020 (N=1,384)	2020/2021 (N=74)	2021/2022 (N=1,263)	2022/2023 (N=2,102)	Overall (N=6,787)
Age Group						
0 - <6 months	47 (2.4%)	29 (2.1%)	2 (2.7%)	39 (3.1%)	73 (3.5%)	190 (2.8%)
6 - <12 months	61 (3.1%)	46 (3.3%)	1 (1.4%)	63 (5.0%)	66 (3.1%)	237 (3.5%)
1 - <2 years	78 (4.0%)	57 (4.1%)	10 (13.5%)	82 (6.5%)	97 (4.6%)	324 (4.8%)
2 - 4 years	89 (4.5%)	45 (3.3%)	12 (16.2%)	146 (11.6%)	177 (8.4%)	469 (6.9%)
5 - 17 years	66 (3.4%)	29 (2.1%)	6 (8.1%)	71 (5.6%)	107 (5.1%)	279 (4.1%)
18 - 49 years	199 (10.1%)	160 (11.6%)	9 (12.2%)	138 (10.9%)	181 (8.6%)	687 (10.1%)
50 - 64 years	332 (16.9%)	259 (18.7%)	10 (13.5%)	198 (15.7%)	320 (15.2%)	1,119 (16.5%)
65 - 74 years	376 (19.1%)	282 (20.4%)	5 (6.8%)	211 (16.7%)	391 (18.6%)	1,265 (18.6%)
75 - 85 years	414 (21.1%)	274 (19.8%)	15 (20.3%)	197 (15.6%)	401 (19.1%)	1,301 (19.2%)
85+ years	302 (15.4%)	203 (14.7%)	4 (5.4%)	118 (9.3%)	289 (13.7%)	916 (13.5%)
Sex						
Female	1,131 (57.6%)	800 (57.8%)	39 (52.7%)	728 (57.6%)	1,235 (58.8%)	3,933 (57.9%)
Male	833 (42.4%)	584 (42.2%)	35 (47.3%)	534 (42.3%)	867 (41.2%)	2,853 (42.0%)
Unknown	0 (0%)	0 (0%)	0 (0%)	1 (0.1%)	0 (0%)	1 (0.0%)
Race						
White	1,392 (70.9%)	1,034 (74.7%)	42 (56.8%)	868 (68.7%)	1,380 (65.7%)	4,716 (69.5%)
Black or African American	199 (10.1%)	128 (9.2%)	6 (8.1%)	120 (9.5%)	176 (8.4%)	629 (9.3%)
Asian	94 (4.8%)	52 (3.8%)	6 (8.1%)	63 (5.0%)	128 (6.1%)	343 (5.1%)

	2018/2019 (N=1,964)	2019/2020 (N=1,384)	2020/2021 (N=74)	2021/2022 (N=1,263)	2022/2023 (N=2,102)	Overall (N=6,787)
American Indian or Alaska Native	14 (0.7%)	6 (0.4%)	0 (0%)	5 (0.4%)	23 (1.1%)	48 (0.7%)
Native Hawaiian or Other Pacific Islander	6 (0.3%)	10 (0.7%)	0 (0%)	9 (0.7%)	5 (0.2%)	30 (0.4%)
Other Race	188 (9.6%)	111 (8.0%)	19 (25.7%)	143 (11.3%)	255 (12.1%)	716 (10.5%)
Declined to answer	16 (0.8%)	6 (0.4%)	0 (0%)	10 (0.8%)	13 (0.6%)	45 (0.7%)
Unknown	55 (2.8%)	37 (2.7%)	1 (1.4%)	45 (3.6%)	122 (5.8%)	260 (3.8%)
Ethnicity						
Hispanic or Latino	216 (11.0%)	158 (11.4%)	21 (28.4%)	200 (15.8%)	318 (15.1%)	913 (13.5%)
Not Hispanic or Latino	1,527 (77.7%)	1,091 (78.8%)	50 (67.6%)	979 (77.5%)	1,644 (78.2%)	5,291 (78.0%)
Declined to answer	11 (0.6%)	6 (0.4%)	0 (0%)	3 (0.2%)	9 (0.4%)	29 (0.4%)
Unknown	210 (10.7%)	129 (9.3%)	3 (4.1%)	81 (6.4%)	131 (6.2%)	554 (8.2%)
Comorbidities						
Asthma	279 (14.2%)	205 (14.8%)	8 (10.8%)	194 (15.4%)	354 (16.8%)	1,040 (15.3%)
Chronic Lung Disease	206 (10.5%)	167 (12.1%)	4 (5.4%)	140 (11.1%)	178 (8.5%)	695 (10.2%)

Time series analysis

The rate of HMPV-associated hospitalization is shown in figure 5. Figure 6 shows seasonal trends.

Figure 5: Rate of weekly HMPV-associated hospitalizations compared to all hospital admissions since October 2018

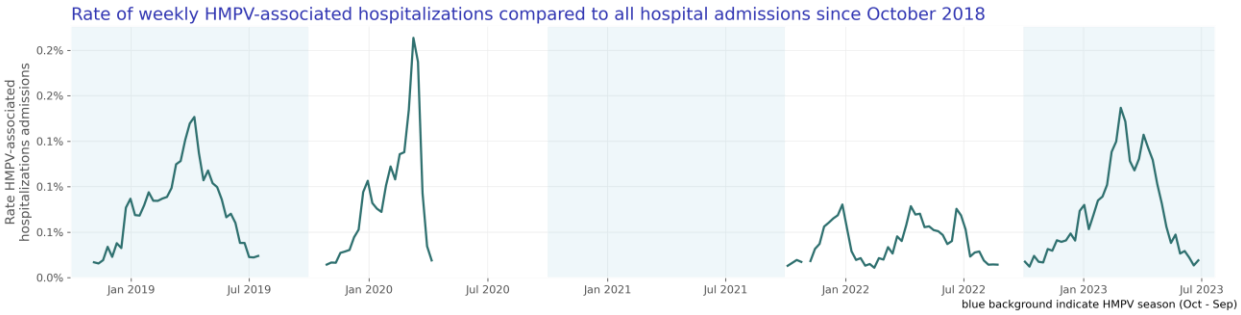
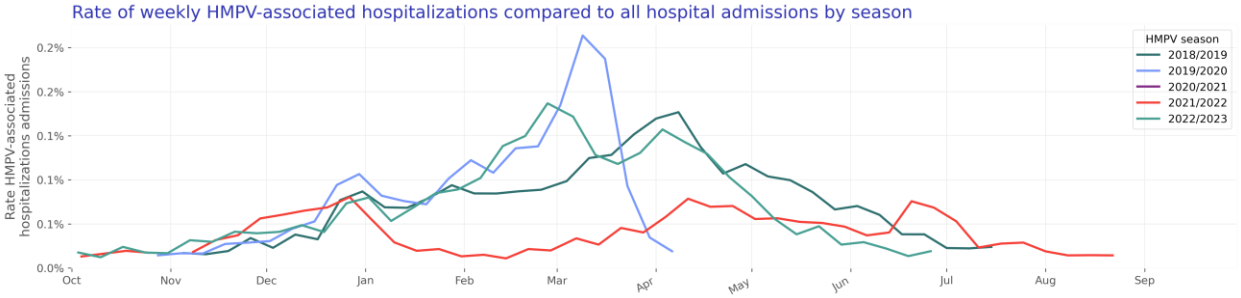


Figure 6: Rate of weekly HMPV-associated hospitalizations compared to all hospital admissions by season



Influenza

Our influenza study population consists of 22,847 hospitalizations of 22,739 unique patients.

The demographics of patients are as follows:

Table 4: Influenza Demographics

	2018/2019 (N=6,310)	2019/2020 (N=6,561)	2020/2021 (N=97)	2021/2022 (N=1,664)	2022/2023 (N=6,594)	Overall (N=21,226)
Age Group						
0 - <6 months	72 (1.1%)	80 (1.2%)	0 (0%)	7 (0.4%)	33 (0.5%)	192 (0.9%)
6 - <12 months	36 (0.6%)	52 (0.8%)	0 (0%)	8 (0.5%)	31 (0.5%)	127 (0.6%)
1 - <2 years	57 (0.9%)	70 (1.1%)	0 (0%)	10 (0.6%)	35 (0.5%)	172 (0.8%)
2 - 4 years	87 (1.4%)	109 (1.7%)	2 (2.1%)	20 (1.2%)	103 (1.6%)	321 (1.5%)

	2018/2019 (N=6,310)	2019/2020 (N=6,561)	2020/2021 (N=97)	2021/2022 (N=1,664)	2022/2023 (N=6,594)	Overall (N=21,226)
5 - 17 years	170 (2.7%)	206 (3.1%)	2 (2.1%)	76 (4.6%)	250 (3.8%)	704 (3.3%)
18 - 49 years	963 (15.3%)	1,271 (19.4%)	19 (19.6%)	393 (23.6%)	1,291 (19.6%)	3,937 (18.5%)
50 - 64 years	1,405 (22.3%)	1,605 (24.5%)	22 (22.7%)	287 (17.2%)	1,285 (19.5%)	4,604 (21.7%)
65 - 74 years	1,284 (20.3%)	1,285 (19.6%)	15 (15.5%)	324 (19.5%)	1,416 (21.5%)	4,324 (20.4%)
75 - 85 years	1,340 (21.2%)	1,111 (16.9%)	25 (25.8%)	333 (20.0%)	1,341 (20.3%)	4,150 (19.6%)
85+ years	896 (14.2%)	772 (11.8%)	12 (12.4%)	206 (12.4%)	809 (12.3%)	2,695 (12.7%)
Sex						
Female	3,447 (54.6%)	3,531 (53.8%)	43 (44.3%)	958 (57.6%)	3,645 (55.3%)	11,624 (54.8%)
Male	2,861 (45.3%)	3,026 (46.1%)	54 (55.7%)	706 (42.4%)	2,946 (44.7%)	9,593 (45.2%)
Unknown	2 (0.0%)	4 (0.1%)	0 (0%)	0 (0%)	3 (0.0%)	9 (0.0%)
Race						
White	4,615 (73.1%)	4,388 (66.9%)	67 (69.1%)	1,151 (69.2%)	4,599 (69.7%)	14,820 (69.8%)
Black or African American	658 (10.4%)	934 (14.2%)	15 (15.5%)	222 (13.3%)	808 (12.3%)	2,637 (12.4%)
Asian	256 (4.1%)	316 (4.8%)	3 (3.1%)	65 (3.9%)	272 (4.1%)	912 (4.3%)
American Indian or Alaska Native	47 (0.7%)	40 (0.6%)	1 (1.0%)	32 (1.9%)	73 (1.1%)	193 (0.9%)
Native Hawaiian or Other Pacific Islander	23 (0.4%)	32 (0.5%)	1 (1.0%)	13 (0.8%)	30 (0.5%)	99 (0.5%)
Other Race	567 (9.0%)	641 (9.8%)	8 (8.2%)	126 (7.6%)	572 (8.7%)	1,914 (9.0%)
Declined to answer	19 (0.3%)	33 (0.5%)	0 (0%)	4 (0.2%)	36 (0.5%)	92 (0.4%)
Unknown	125 (2.0%)	177 (2.7%)	2 (2.1%)	51 (3.1%)	204 (3.1%)	559 (2.6%)

	2018/2019 (N=6,310)	2019/2020 (N=6,561)	2020/2021 (N=97)	2021/2022 (N=1,664)	2022/2023 (N=6,594)	Overall (N=21,226)
Ethnicity						
Hispanic or Latino	680 (10.8%)	930 (14.2%)	14 (14.4%)	231 (13.9%)	893 (13.5%)	2,748 (12.9%)
Not Hispanic or Latino	4,881 (77.4%)	4,903 (74.7%)	70 (72.2%)	1,316 (79.1%)	5,277 (80.0%)	16,447 (77.5%)
Declined to answer	26 (0.4%)	34 (0.5%)	0 (0%)	3 (0.2%)	34 (0.5%)	97 (0.5%)
Unknown	723 (11.5%)	694 (10.6%)	13 (13.4%)	114 (6.9%)	390 (5.9%)	1,934 (9.1%)
Comorbidities						
Asthma	845 (13.4%)	792 (12.1%)	4 (4.1%)	255 (15.3%)	1,045 (15.8%)	2,941 (13.9%)
Chronic Lung Disease	622 (9.9%)	472 (7.2%)	2 (2.1%)	148 (8.9%)	619 (9.4%)	1,863 (8.8%)

Time series analysis

The rate of influenza-associated hospitalization is shown in figure 7. Figure 8 shows seasonal trends.

Figure 7: Rate of weekly influenza-associated hospitalizations compared to all hospital admissions since October 2018

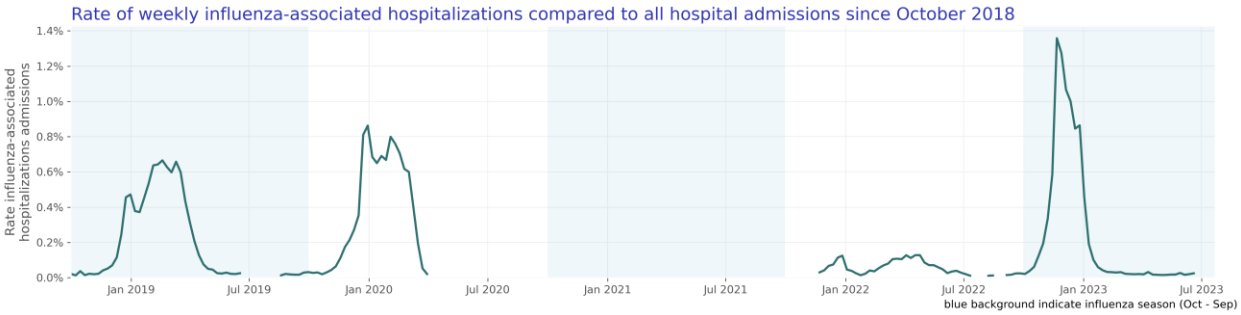
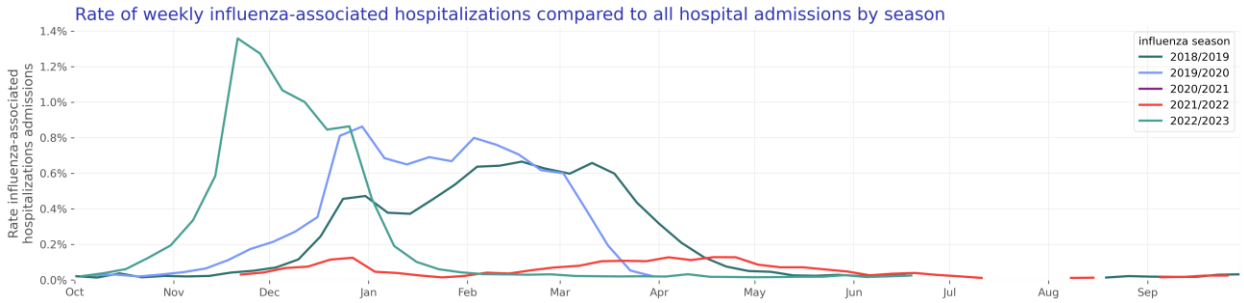


Figure 8: Rate of weekly influenza-associated hospitalizations compared to all hospital admissions by season



Parainfluenza virus

Our parainfluenza virus study population consists of 7,284 hospitalizations of 7,228 unique patients.

The demographics of patients are as follows:

Table 5: Parainfluenza virus Demographics

	2018/2019 (N=2,129)	2019/2020 (N=677)	2020/2021 (N=644)	2021/2022 (N=1,131)	2022/2023 (N=1,678)	Overall (N=6,259)
Age Group						
0 - <6 months	115 (5.4%)	40 (5.9%)	36 (5.6%)	68 (6.0%)	83 (4.9%)	342 (5.5%)
6 - <12 months	61 (2.9%)	16 (2.4%)	27 (4.2%)	46 (4.1%)	57 (3.4%)	207 (3.3%)
1 - <2 years	104 (4.9%)	32 (4.7%)	56 (8.7%)	68 (6.0%)	64 (3.8%)	324 (5.2%)
2 - 4 years	110 (5.2%)	40 (5.9%)	58 (9.0%)	106 (9.4%)	113 (6.7%)	427 (6.8%)
5 - 17 years	83 (3.9%)	39 (5.8%)	47 (7.3%)	65 (5.7%)	95 (5.7%)	329 (5.3%)
18 - 49 years	198 (9.3%)	68 (10.0%)	86 (13.4%)	138 (12.2%)	180 (10.7%)	670 (10.7%)
50 - 64 years	388 (18.2%)	111 (16.4%)	100 (15.5%)	178 (15.7%)	260 (15.5%)	1,037 (16.6%)
65 - 74 years	380 (17.8%)	112 (16.5%)	100 (15.5%)	197 (17.4%)	281 (16.7%)	1,070 (17.1%)
75 - 85 years	423 (19.9%)	130 (19.2%)	81 (12.6%)	160 (14.1%)	319 (19.0%)	1,113 (17.8%)

	2018/2019 (N=2,129)	2019/2020 (N=677)	2020/2021 (N=644)	2021/2022 (N=1,131)	2022/2023 (N=1,678)	Overall (N=6,259)
85+ years	267 (12.5%)	89 (13.1%)	53 (8.2%)	105 (9.3%)	226 (13.5%)	740 (11.8%)
Sex						
Female	1,157 (54.3%)	364 (53.8%)	339 (52.6%)	616 (54.5%)	910 (54.2%)	3,386 (54.1%)
Male	971 (45.6%)	313 (46.2%)	305 (47.4%)	515 (45.5%)	767 (45.7%)	2,871 (45.9%)
Unknown	1 (0.0%)	0 (0%)	0 (0%)	0 (0%)	1 (0.1%)	2 (0.0%)
Race						
White	1,518 (71.3%)	464 (68.5%)	400 (62.1%)	721 (63.7%)	1,096 (65.3%)	4,199 (67.1%)
Black or African American	213 (10.0%)	64 (9.5%)	87 (13.5%)	129 (11.4%)	164 (9.8%)	657 (10.5%)
Asian	114 (5.4%)	47 (6.9%)	29 (4.5%)	78 (6.9%)	109 (6.5%)	377 (6.0%)
American Indian or Alaska Native	11 (0.5%)	3 (0.4%)	7 (1.1%)	13 (1.1%)	14 (0.8%)	48 (0.8%)
Native Hawaiian or Other Pacific Islander	12 (0.6%)	8 (1.2%)	6 (0.9%)	4 (0.4%)	3 (0.2%)	33 (0.5%)
Other Race	177 (8.3%)	72 (10.6%)	93 (14.4%)	130 (11.5%)	201 (12.0%)	673 (10.8%)
Declined to answer	11 (0.5%)	1 (0.1%)	3 (0.5%)	5 (0.4%)	6 (0.4%)	26 (0.4%)
Unknown	73 (3.4%)	18 (2.7%)	19 (3.0%)	51 (4.5%)	85 (5.1%)	246 (3.9%)
Ethnicity						
Hispanic or Latino	208 (9.8%)	73 (10.8%)	103 (16.0%)	161 (14.2%)	207 (12.3%)	752 (12.0%)
Not Hispanic or Latino	1,686 (79.2%)	525 (77.5%)	482 (74.8%)	886 (78.3%)	1,325 (79.0%)	4,904 (78.4%)
Declined to answer	10 (0.5%)	4 (0.6%)	2 (0.3%)	4 (0.4%)	5 (0.3%)	25 (0.4%)
Unknown	225 (10.6%)	75 (11.1%)	57 (8.9%)	80 (7.1%)	141 (8.4%)	578 (9.2%)
Comorbidities						

	2018/2019 (N=2,129)	2019/2020 (N=677)	2020/2021 (N=644)	2021/2022 (N=1,131)	2022/2023 (N=1,678)	Overall (N=6,259)
Asthma	302 (14.2%)	104 (15.4%)	89 (13.8%)	174 (15.4%)	247 (14.7%)	916 (14.6%)
Chronic Lung Disease	247 (11.6%)	88 (13.0%)	37 (5.7%)	118 (10.4%)	172 (10.3%)	662 (10.6%)

Time series analysis

The rate of parainfluenza virus-associated hospitalization is shown in figure 9. Figure 10 shows seasonal trends.

Figure 9: Rate of weekly parainfluenza virus-associated hospitalizations compared to all hospital admissions since October 2018

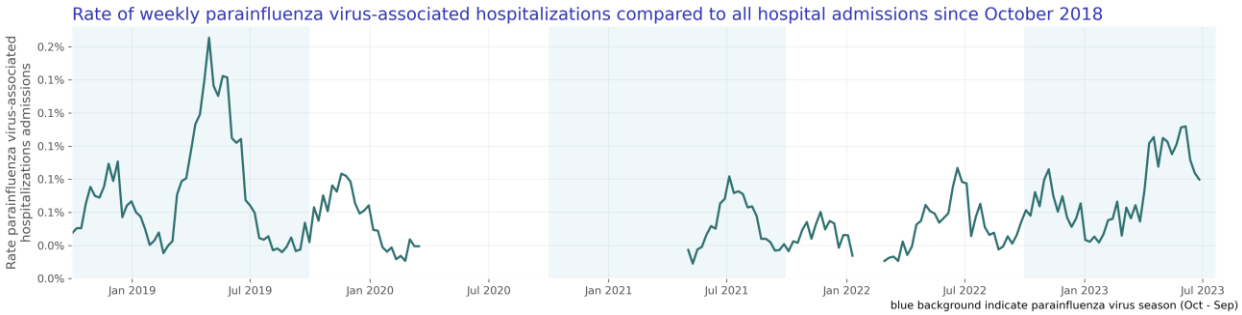
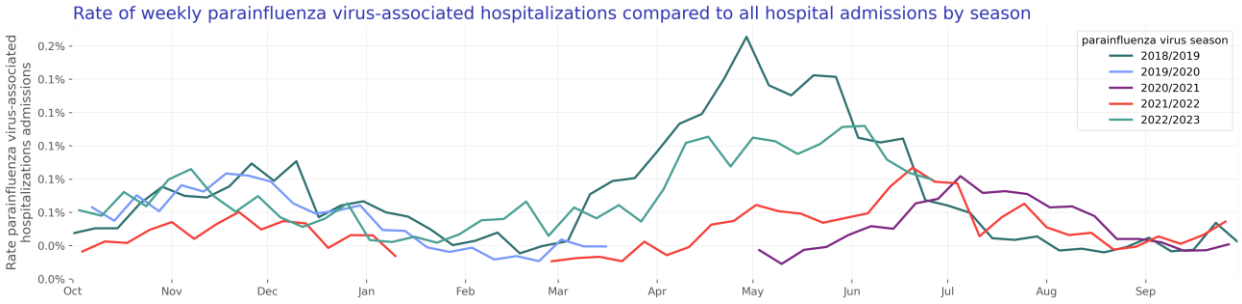


Figure 10: Rate of weekly parainfluenza virus-associated hospitalizations compared to all hospital admissions by season



Respiratory syncytial virus (RSV)

Our RSV study population consists of 14,185 hospitalizations of 14,097 unique patients.

The demographics of patients are as follows:

Table 6: RSV Demographics

	2018/2019 (N=2,807)	2019/2020 (N=2,348)	2020/2021 (N=745)	2021/2022 (N=2,080)	2022/2023 (N=3,378)	Overall (N=11,358)
Age Group						
0 - <6 months	481 (17.1%)	453 (19.3%)	205 (27.5%)	365 (17.5%)	589 (17.4%)	2,093 (18.4%)
6 - <12 months	187 (6.7%)	158 (6.7%)	62 (8.3%)	123 (5.9%)	204 (6.0%)	734 (6.5%)
1 - <2 years	188 (6.7%)	171 (7.3%)	78 (10.5%)	170 (8.2%)	264 (7.8%)	871 (7.7%)
2 - 4 years	214 (7.6%)	164 (7.0%)	60 (8.1%)	189 (9.1%)	340 (10.1%)	967 (8.5%)
5 - 17 years	62 (2.2%)	46 (2.0%)	17 (2.3%)	65 (3.1%)	131 (3.9%)	321 (2.8%)
18 - 49 years	159 (5.7%)	118 (5.0%)	68 (9.1%)	208 (10.0%)	244 (7.2%)	797 (7.0%)
50 - 64 years	330 (11.8%)	265 (11.3%)	81 (10.9%)	250 (12.0%)	360 (10.7%)	1,286 (11.3%)
65 - 74 years	392 (14.0%)	333 (14.2%)	71 (9.5%)	263 (12.6%)	459 (13.6%)	1,518 (13.4%)
75 - 85 years	432 (15.4%)	373 (15.9%)	59 (7.9%)	259 (12.5%)	458 (13.6%)	1,581 (13.9%)
85+ years	362 (12.9%)	267 (11.4%)	44 (5.9%)	188 (9.0%)	329 (9.7%)	1,190 (10.5%)
Sex						
Female	1,482 (52.8%)	1,261 (53.7%)	415 (55.7%)	1,101 (52.9%)	1,792 (53.0%)	6,051 (53.3%)
Male	1,325 (47.2%)	1,084 (46.2%)	330 (44.3%)	979 (47.1%)	1,586 (47.0%)	5,304 (46.7%)
Unknown	0 (0%)	3 (0.1%)	0 (0%)	0 (0%)	0 (0%)	3 (0.0%)
Race						
White	1,895 (67.5%)	1,571 (66.9%)	457 (61.3%)	1,385 (66.6%)	2,214 (65.5%)	7,522 (66.2%)
Black or African American	258 (9.2%)	240 (10.2%)	139 (18.7%)	227 (10.9%)	381 (11.3%)	1,245 (11.0%)
Asian	137 (4.9%)	115 (4.9%)	29 (3.9%)	129 (6.2%)	227 (6.7%)	637 (5.6%)

	2018/2019 (N=2,807)	2019/2020 (N=2,348)	2020/2021 (N=745)	2021/2022 (N=2,080)	2022/2023 (N=3,378)	Overall (N=11,358)
American Indian or Alaska Native	29 (1.0%)	16 (0.7%)	2 (0.3%)	30 (1.4%)	39 (1.2%)	116 (1.0%)
Native Hawaiian or Other Pacific Islander	17 (0.6%)	14 (0.6%)	1 (0.1%)	25 (1.2%)	29 (0.9%)	86 (0.8%)
Other Race	312 (11.1%)	292 (12.4%)	84 (11.3%)	207 (10.0%)	332 (9.8%)	1,227 (10.8%)
Declined to answer	22 (0.8%)	4 (0.2%)	4 (0.5%)	4 (0.2%)	17 (0.5%)	51 (0.4%)
Unknown	137 (4.9%)	96 (4.1%)	29 (3.9%)	73 (3.5%)	139 (4.1%)	474 (4.2%)
Ethnicity						
Hispanic or Latino	362 (12.9%)	352 (15.0%)	118 (15.8%)	313 (15.0%)	529 (15.7%)	1,674 (14.7%)
Not Hispanic or Latino	2,093 (74.6%)	1,706 (72.7%)	565 (75.8%)	1,633 (78.5%)	2,611 (77.3%)	8,608 (75.8%)
Declined to answer	18 (0.6%)	5 (0.2%)	4 (0.5%)	9 (0.4%)	30 (0.9%)	66 (0.6%)
Unknown	334 (11.9%)	285 (12.1%)	58 (7.8%)	125 (6.0%)	208 (6.2%)	1,010 (8.9%)
Comorbidities						
Asthma	330 (11.8%)	270 (11.5%)	68 (9.1%)	265 (12.7%)	480 (14.2%)	1,413 (12.4%)
Chronic Lung Disease	228 (8.1%)	182 (7.8%)	35 (4.7%)	143 (6.9%)	265 (7.8%)	853 (7.5%)

Time series analysis

The rate of RSV-associated hospitalization is shown in figure 11. Figure 12 shows seasonal trends.

Figure 11: Rate of weekly RSV-associated hospitalizations compared to all hospital admissions since October 2018

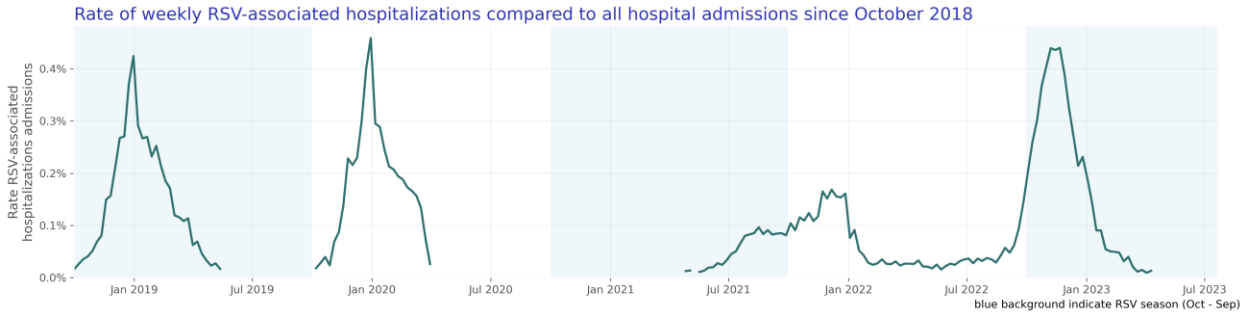
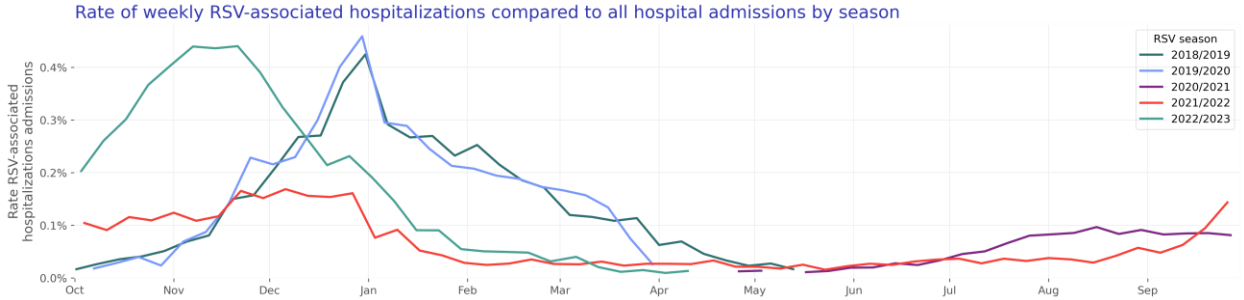


Figure 12: Rate of weekly RSV-associated hospitalizations compared to all hospital admissions by season



Rhinovirus

Our rhinovirus study population consists of 29,740 hospitalizations of 28,292 unique patients.

The demographics of patients are as follows:

Table 7: Rhinovirus Demographics

	2018/2019 (N=7,698)	2019/2020 (N=4,096)	2020/2021 (N=3,463)	2021/2022 (N=4,665)	2022/2023 (N=5,524)	Overall (N=25,446)
Age Group						
0 - <6 months	509 (6.6%)	263 (6.4%)	231 (6.7%)	365 (7.8%)	332 (6.0%)	1,700 (6.7%)
6 - <12 months	210 (2.7%)	131 (3.2%)	132 (3.8%)	205 (4.4%)	153 (2.8%)	831 (3.3%)
1 - <2 years	375 (4.9%)	178 (4.3%)	275 (7.9%)	443 (9.5%)	307 (5.6%)	1,578 (6.2%)
2 - 4 years	509 (6.6%)	279 (6.8%)	348 (10.0%)	679 (14.6%)	551 (10.0%)	2,366 (9.3%)

	2018/2019 (N=7,698)	2019/2020 (N=4,096)	2020/2021 (N=3,463)	2021/2022 (N=4,665)	2022/2023 (N=5,524)	Overall (N=25,446)
5 - 17 years	555 (7.2%)	268 (6.5%)	448 (12.9%)	670 (14.4%)	740 (13.4%)	2,681 (10.5%)
18 - 49 years	1,139 (14.8%)	689 (16.8%)	724 (20.9%)	627 (13.4%)	788 (14.3%)	3,967 (15.6%)
50 - 64 years	1,411 (18.3%)	703 (17.2%)	444 (12.8%)	549 (11.8%)	758 (13.7%)	3,865 (15.2%)
65 - 74 years	1,192 (15.5%)	616 (15.0%)	374 (10.8%)	486 (10.4%)	756 (13.7%)	3,424 (13.5%)
75 - 85 years	1,066 (13.8%)	560 (13.7%)	303 (8.7%)	378 (8.1%)	670 (12.1%)	2,977 (11.7%)
85+ years	732 (9.5%)	409 (10.0%)	184 (5.3%)	263 (5.6%)	469 (8.5%)	2,057 (8.1%)
Sex						
Female	3,875 (50.3%)	2,036 (49.7%)	1,728 (49.9%)	2,199 (47.1%)	2,787 (50.5%)	12,625 (49.6%)
Male	3,820 (49.6%)	2,057 (50.2%)	1,733 (50.0%)	2,464 (52.8%)	2,735 (49.5%)	12,809 (50.3%)
Unknown	3 (0.0%)	3 (0.1%)	2 (0.1%)	2 (0.0%)	2 (0.0%)	12 (0.0%)
Race						
White	5,026 (65.3%)	2,724 (66.5%)	2,066 (59.7%)	2,696 (57.8%)	3,263 (59.1%)	15,775 (62.0%)
Black or African American	1,022 (13.3%)	495 (12.1%)	526 (15.2%)	635 (13.6%)	678 (12.3%)	3,356 (13.2%)
Asian	365 (4.7%)	183 (4.5%)	164 (4.7%)	278 (6.0%)	357 (6.5%)	1,347 (5.3%)
American Indian or Alaska Native	71 (0.9%)	47 (1.1%)	31 (0.9%)	50 (1.1%)	47 (0.9%)	246 (1.0%)
Native Hawaiian or Other Pacific Islander	36 (0.5%)	24 (0.6%)	23 (0.7%)	23 (0.5%)	29 (0.5%)	135 (0.5%)
Other Race	863 (11.2%)	467 (11.4%)	540 (15.6%)	726 (15.6%)	763 (13.8%)	3,359 (13.2%)
Declined to answer	40 (0.5%)	19 (0.5%)	19 (0.5%)	27 (0.6%)	41 (0.7%)	146 (0.6%)
Unknown	275 (3.6%)	137 (3.3%)	94 (2.7%)	230 (4.9%)	346 (6.3%)	1,082 (4.3%)

	2018/2019 (N=7,698)	2019/2020 (N=4,096)	2020/2021 (N=3,463)	2021/2022 (N=4,665)	2022/2023 (N=5,524)	Overall (N=25,446)
Ethnicity						
Hispanic or Latino	891 (11.6%)	513 (12.5%)	541 (15.6%)	791 (17.0%)	858 (15.5%)	3,594 (14.1%)
Not Hispanic or Latino	5,986 (77.8%)	3,182 (77.7%)	2,640 (76.2%)	3,510 (75.2%)	4,181 (75.7%)	19,499 (76.6%)
Declined to answer	40 (0.5%)	17 (0.4%)	23 (0.7%)	20 (0.4%)	35 (0.6%)	135 (0.5%)
Unknown	781 (10.1%)	384 (9.4%)	259 (7.5%)	344 (7.4%)	450 (8.1%)	2,218 (8.7%)
Comorbidities						
Asthma	1,236 (16.1%)	689 (16.8%)	533 (15.4%)	761 (16.3%)	981 (17.8%)	4,200 (16.5%)
Chronic Lung Disease	765 (9.9%)	451 (11.0%)	227 (6.6%)	304 (6.5%)	444 (8.0%)	2,191 (8.6%)

Time series analysis

The rate of rhinovirus-associated hospitalization is shown in figure 13. Figure 14 shows seasonal trends.

Figure 13: Rate of weekly rhinovirus-associated hospitalizations compared to all hospital admissions since October 2018

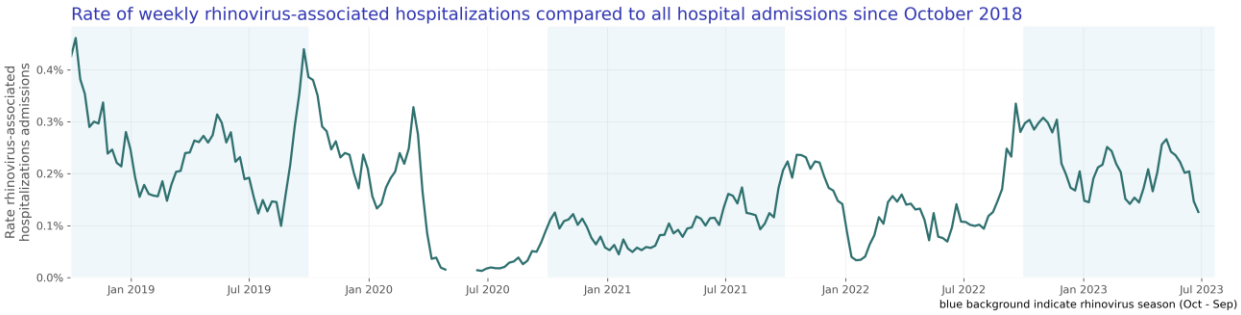
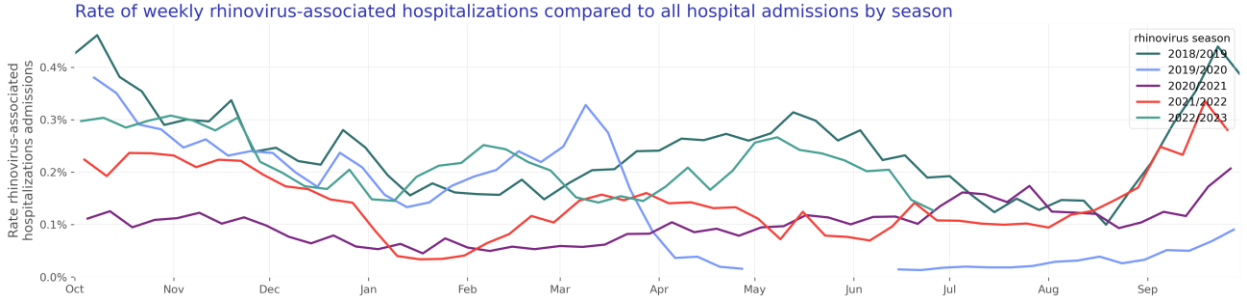


Figure 14: Rate of weekly rhinovirus-associated hospitalizations compared to all hospital admissions by season



Infants and children (age 0-4)

Estimates of the hospitalization rate of infants and children (defined as individuals less than five years of age) with respiratory virus infections are higher than other age groups, except adults 65 and older (Centers for Disease Control and Prevention, 2023c; Centers for Disease Control and Prevention, 2023d). In table 8 we report counts for demographic factors of this high-risk population. In the future, we plan to include high-risk comorbid states, such as congenital heart disease, preterm birth, and cystic fibrosis (Committee on Infectious Diseases and Bronchiolitis Guidelines Committee et al., 2014).

Table 8: Table 1 for infants and children less than five

	2018/2019 (N=3,590)	2019/2020 (N=2,477)	2020/2021 (N=1,926)	2021/2022 (N=3,958)	2022/2023 (N=3,937)	Overall (N=15,888)
Respiratory Virus						
COVID	0 (0%)	64 (2.6%)	331 (17.2%)	756 (19.1%)	265 (6.7%)	1,416 (8.9%)
HMPV	275 (7.7%)	177 (7.1%)	25 (1.3%)	330 (8.3%)	413 (10.5%)	1,220 (7.7%)
Influenza	252 (7.0%)	311 (12.6%)	2 (0.1%)	45 (1.1%)	202 (5.1%)	812 (5.1%)
Parainfluenza virus	390 (10.9%)	128 (5.2%)	177 (9.2%)	288 (7.3%)	317 (8.1%)	1,300 (8.2%)
RSV	1,070 (29.8%)	946 (38.2%)	405 (21.0%)	847 (21.4%)	1,397 (35.5%)	4,665 (29.4%)
Rhinovirus	1,603 (44.7%)	851 (34.4%)	986 (51.2%)	1,692 (42.7%)	1,343 (34.1%)	6,475 (40.8%)
Age Group						

	2018/2019 (N=3,590)	2019/2020 (N=2,477)	2020/2021 (N=1,926)	2021/2022 (N=3,958)	2022/2023 (N=3,937)	Overall (N=15,888)
0 - <6 months	1,224 (34.1%)	907 (36.6%)	662 (34.4%)	1,213 (30.6%)	1,243 (31.6%)	5,249 (33.0%)
6 - <12 months	555 (15.5%)	406 (16.4%)	256 (13.3%)	549 (13.9%)	554 (14.1%)	2,320 (14.6%)
1 - <2 years	802 (22.3%)	516 (20.8%)	469 (24.4%)	883 (22.3%)	802 (20.4%)	3,472 (21.9%)
2 - 4 years	1,009 (28.1%)	648 (26.2%)	539 (28.0%)	1,313 (33.2%)	1,338 (34.0%)	4,847 (30.5%)
Sex						
Female	1,507 (42.0%)	1,081 (43.6%)	805 (41.8%)	1,639 (41.4%)	1,702 (43.2%)	6,734 (42.4%)
Male	2,082 (58.0%)	1,396 (56.4%)	1,121 (58.2%)	2,319 (58.6%)	2,235 (56.8%)	9,153 (57.6%)
Unknown	1 (0.0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0.0%)
Race						
White	1,716 (47.8%)	1,244 (50.2%)	968 (50.3%)	2,008 (50.7%)	1,913 (48.6%)	7,849 (49.4%)
Black or African American	499 (13.9%)	337 (13.6%)	312 (16.2%)	546 (13.8%)	506 (12.9%)	2,200 (13.8%)
Asian	256 (7.1%)	164 (6.6%)	109 (5.7%)	265 (6.7%)	349 (8.9%)	1,143 (7.2%)
American Indian or Alaska Native	53 (1.5%)	26 (1.0%)	15 (0.8%)	62 (1.6%)	62 (1.6%)	218 (1.4%)
Native Hawaiian or Other Pacific Islander	40 (1.1%)	34 (1.4%)	24 (1.2%)	42 (1.1%)	42 (1.1%)	182 (1.1%)
Other Race	733 (20.4%)	503 (20.3%)	395 (20.5%)	694 (17.5%)	656 (16.7%)	2,981 (18.8%)
Declined to answer	37 (1.0%)	8 (0.3%)	12 (0.6%)	25 (0.6%)	31 (0.8%)	113 (0.7%)
Unknown	256 (7.1%)	161 (6.5%)	91 (4.7%)	316 (8.0%)	378 (9.6%)	1,202 (7.6%)
Ethnicity						
Hispanic or Latino	840 (23.4%)	622 (25.1%)	427 (22.2%)	864 (21.8%)	912 (23.2%)	3,665 (23.1%)

	2018/2019 (N=3,590)	2019/2020 (N=2,477)	2020/2021 (N=1,926)	2021/2022 (N=3,958)	2022/2023 (N=3,937)	Overall (N=15,888)
Not Hispanic or Latino	2,250 (62.7%)	1,505 (60.8%)	1,338 (69.5%)	2,768 (69.9%)	2,659 (67.5%)	10,520 (66.2%)
Declined to answer	31 (0.9%)	9 (0.4%)	12 (0.6%)	15 (0.4%)	32 (0.8%)	99 (0.6%)
Unknown	469 (13.1%)	341 (13.8%)	149 (7.7%)	311 (7.9%)	334 (8.5%)	1,604 (10.1%)

Time series analysis

The rate of respiratory virus-associated hospitalizations compared to all hospitalizations for infants and children under five is shown in figure 15. Patients were included in this calculation on the first day of their hospitalization. If their stay was greater than one day, they were not counted in subsequent dates. Figure 16 shows the same data stacked to represent the combined impact of the viruses.

Figure 15: Rate of weekly respiratory virus-associated hospitalizations compared to all hospital admissions since October 2018 for infants and children under five

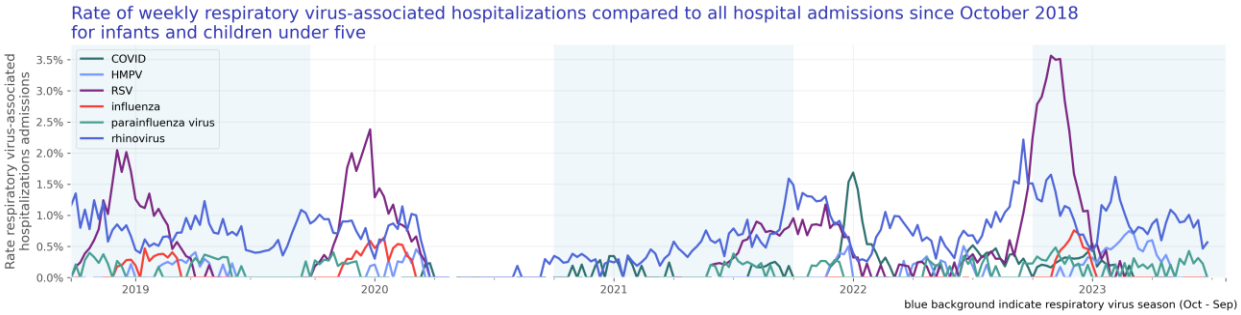
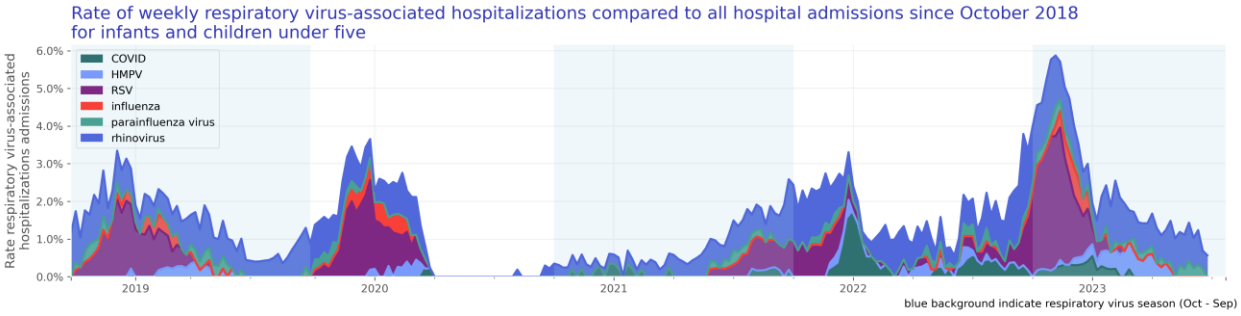


Figure 16: Rate of weekly respiratory virus-associated hospitalizations compared to all hospital admissions since October 2018 for infants and children under five



Older adults (age 65 and over)

Respiratory viruses are also a major source of infection and hospitalizations in older adults (defined here as patients 65 years of age or older). Incidence has been estimated between 3-10% annually for RSV in older adults (Boyce et al., 2000) and 8-10% for influenza in adults (Tokars et al., 2018).

Often, as is the case with influenza, older adults are at higher risk for hospitalization and death than other age groups (Czaja et al. 2019). There are comorbidities that are associated with increased hospitalization risk for older adults, such as congestive heart failure and chronic lung disease (Lee et al., 2013). Further, asthma, COPD, and congestive heart failure can exacerbate respiratory virus infections. Here we report counts for a selection of high-risk medical conditions such as chronic lung diseases and asthma. In the future, we plan to include other high-risk groups.

Table 9: Table 1 for older adults (65 years of age and older)

	2018/2019 (N=9,858)	2019/2020 (N=17,072)	2020/2021 (N=28,423)	2021/2022 (N=33,579)	2022/2023 (N=25,340)	Overall (N=114,272)
Respiratory Virus						
COVID	0 (0%)	10,256 (60.1%)	27,078 (95.3%)	29,891 (89.0%)	16,726 (66.0%)	83,951 (73.5%)
HMPV	1,092 (11.1%)	759 (4.4%)	24 (0.1%)	526 (1.6%)	1,081 (4.3%)	3,482 (3.0%)
Influenza	3,520 (35.7%)	3,168 (18.6%)	52 (0.2%)	863 (2.6%)	3,566 (14.1%)	11,169 (9.8%)
Parainfluenza virus	1,070 (10.9%)	331 (1.9%)	234 (0.8%)	462 (1.4%)	826 (3.3%)	2,923 (2.6%)
RSV	1,186 (12.0%)	973 (5.7%)	174 (0.6%)	710 (2.1%)	1,246 (4.9%)	4,289 (3.8%)
Rhinovirus	2,990 (30.3%)	1,585 (9.3%)	861 (3.0%)	1,127 (3.4%)	1,895 (7.5%)	8,458 (7.4%)
Age Group						
65 - 74 years	3,624 (36.8%)	7,088 (41.5%)	12,310 (43.3%)	12,717 (37.9%)	8,424 (33.2%)	44,163 (38.6%)
75 - 85 years	3,675 (37.3%)	6,127 (35.9%)	10,122 (35.6%)	12,559 (37.4%)	9,725 (38.4%)	42,208 (36.9%)
85+ years	2,559 (26.0%)	3,857 (22.6%)	5,991 (21.1%)	8,303 (24.7%)	7,191 (28.4%)	27,901 (24.4%)

	2018/2019 (N=9,858)	2019/2020 (N=17,072)	2020/2021 (N=28,423)	2021/2022 (N=33,579)	2022/2023 (N=25,340)	Overall (N=114,272)
Sex						
Female	5,545 (56.2%)	8,737 (51.2%)	13,997 (49.2%)	17,062 (50.8%)	13,463 (53.1%)	58,804 (51.5%)
Male	4,312 (43.7%)	8,310 (48.7%)	14,359 (50.5%)	16,488 (49.1%)	11,859 (46.8%)	55,328 (48.4%)
Unknown	1 (0.0%)	25 (0.1%)	67 (0.2%)	29 (0.1%)	18 (0.1%)	140 (0.1%)
Race						
White	8,043 (81.6%)	11,945 (70.0%)	21,618 (76.1%)	26,313 (78.4%)	19,699 (77.7%)	87,618 (76.7%)
Black or African American	639 (6.5%)	2,111 (12.4%)	2,372 (8.3%)	2,773 (8.3%)	1,861 (7.3%)	9,756 (8.5%)
Asian	373 (3.8%)	833 (4.9%)	1,175 (4.1%)	1,271 (3.8%)	1,113 (4.4%)	4,765 (4.2%)
American Indian or Alaska Native	27 (0.3%)	65 (0.4%)	118 (0.4%)	157 (0.5%)	135 (0.5%)	502 (0.4%)
Native Hawaiian or Other Pacific Islander	13 (0.1%)	26 (0.2%)	52 (0.2%)	47 (0.1%)	44 (0.2%)	182 (0.2%)
Other Race	534 (5.4%)	1,566 (9.2%)	2,323 (8.2%)	2,175 (6.5%)	1,609 (6.3%)	8,207 (7.2%)
Declined to answer	32 (0.3%)	66 (0.4%)	104 (0.4%)	140 (0.4%)	133 (0.5%)	475 (0.4%)
Unknown	197 (2.0%)	460 (2.7%)	661 (2.3%)	703 (2.1%)	746 (2.9%)	2,767 (2.4%)
Ethnicity						
Hispanic or Latino	515 (5.2%)	2,006 (11.8%)	3,328 (11.7%)	2,635 (7.8%)	1,744 (6.9%)	10,228 (9.0%)
Not Hispanic or Latino	8,186 (83.0%)	13,050 (76.4%)	22,144 (77.9%)	28,314 (84.3%)	21,463 (84.7%)	93,157 (81.5%)
Declined to answer	33 (0.3%)	71 (0.4%)	110 (0.4%)	136 (0.4%)	136 (0.5%)	486 (0.4%)
Unknown	1,124 (11.4%)	1,945 (11.4%)	2,841 (10.0%)	2,494 (7.4%)	1,997 (7.9%)	10,401 (9.1%)
Comorbidities						
Asthma	1,260 (12.8%)	1,505 (8.8%)	1,916 (6.7%)	3,133 (9.3%)	2,925 (11.5%)	10,739 (9.4%)

	2018/2019 (N=9,858)	2019/2020 (N=17,072)	2020/2021 (N=28,423)	2021/2022 (N=33,579)	2022/2023 (N=25,340)	Overall (N=114,272)
Chronic Lung Disease	1,248 (12.7%)	1,296 (7.6%)	1,754 (6.2%)	2,793 (8.3%)	2,485 (9.8%)	9,576 (8.4%)

Time series analysis

The rate of respiratory virus-associated hospitalizations compared to all hospitalizations for adults 65 and over is shown in figure 17. Patients were included in this calculation on the first day of their hospitalization. If their stay was greater than one day, they were not counted in subsequent dates. Figure 18 shows the same data stacked to represent the combined impact of the viruses.

Figure 17: Rate of weekly respiratory virus-associated hospitalizations compared to all hospital admissions since October 2018 for adults 65 years or older

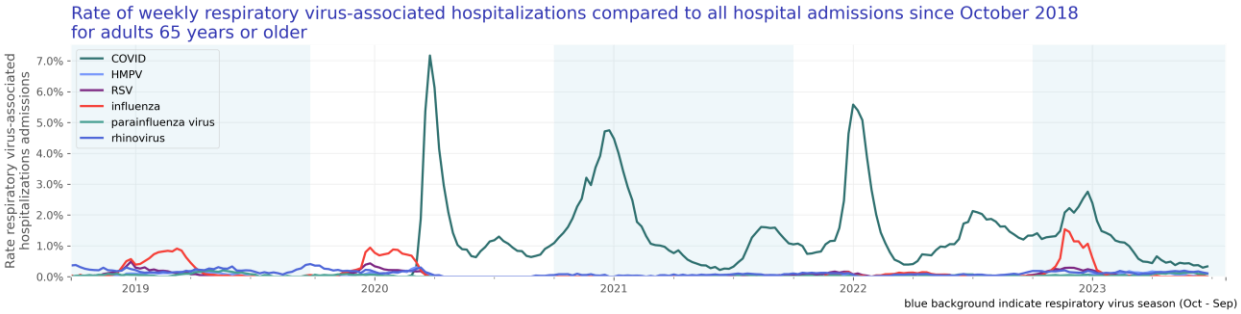
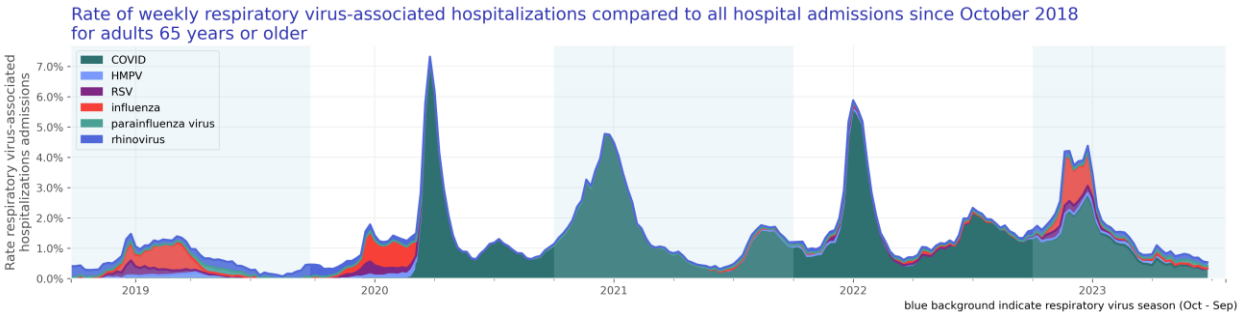


Figure 18: Rate of weekly respiratory virus-associated hospitalizations compared to all hospital admissions since October 2018 for adults 65 years or older



Trends in surveillance

Similar to previous years, the 2023 summer months show decreased rates of hospitalizations associated with respiratory viruses, both for individual viruses and overall. As, we've reported with previous reports, year-over-year trends indicate that overall counts of respiratory virus-associated hospitalizations collectively peaked slightly earlier (Nov-Dec), at a lower level, and sustained for a similar period (5 weeks)

this season when compared to the 2021/2022 season. While the 2021/2022 season was driven predominantly by COVID, the 2022/2023 season was driven by both COVID and RSV.

Individual virus hospitalization counts in the 2022/2023 season show several notable trends. Older adults make up a larger percentage of those hospitalized for COVID in the 2022/2023 season than in previous years. The number of admissions due to HMPV exceeded previous annual highs with 2–4-year-olds making up a larger proportion of the population than in prior years. Hospitalizations for influenza returned to higher pre-pandemic levels and rose earlier and sharper than prior seasons. Parainfluenza virus associated hospitalizations continue to climb year-over-year but have not reached pre-pandemic levels. Hospitalizations for RSV increased to the highest recorded annual total. Rhinovirus-associated hospitalizations rose to the highest level since pre-pandemic seasons and is most concentrated in children.

Infants, children and older adults constituted a larger proportion of the respiratory virus-associated hospitalized population this season when compared to prior seasons. Hospitalizations in infants and children were increased this season (2022/2023) compared to last season (2021/2022). This was due to increases in RSV- and rhinovirus-related hospitalizations. This difference is most pronounced in the number of RSV infections in the 2–4-year-old age group.

In the elderly, COVID associated hospitalizations continue to comprise a large proportion of the overall respiratory virus associated hospitalizations. Other viruses have returned to pre-pandemic levels after dropping during the pandemic.

This report presents updated data through the end of June 2023. Based on this updated data, most respiratory viruses are at seasonal lows which are typically associated with this time of year. Parainfluenza and rhinovirus are exceptions that do not exhibit strong seasonal trends.

Limitations

- All data are preliminary and may change as additional data are obtained. These findings are consistent with data accessed July 21, 2023.
- These are raw counts and post-stratification methods have not been conducted.
- This analysis does not include patients hospitalized with a respiratory virus who were not tested for it or were tested later in their medical care (when laboratory tests results would have returned a negative result).
- Cohorts with small counts may be suppressed during the de-identification process leading to the appearance of zero patients for a given time period.

- The unknowns in this report either indicate the value was not included in the individual's electronic health record or that it was excluded from the data to protect an individual's identity as a part of Truveta's commitment to privacy (Truveta, 2022).

Suggested citation

Suggested citation: "Truveta Monitoring Report: Respiratory Viruses, Truveta Inc. Truveta.com/research. Accessed on DATE".

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Supplementary material

Table S1: LOINC codes for COVID-19 lab test

Code System	Concept Code	Concept Name
LOINC	94306-8	SARS-CoV-2 (COVID-19) RNA panel - Specimen by NAA with probe detection
LOINC	94307-6	SARS-CoV-2 (COVID-19) N gene [Presence] in Specimen by Nucleic acid amplification using CDC primer-probe set N1
LOINC	94308-4	SARS-CoV-2 (COVID-19) N gene [Presence] in Specimen by Nucleic acid amplification using CDC primer-probe set N2
LOINC	94309-2	SARS-CoV-2 (COVID-19) RNA [Presence] in Specimen by NAA with probe detection
LOINC	94310-0	SARS-like coronavirus N gene [Presence] in Specimen by NAA with probe detection
LOINC	94314-2	SARS-CoV-2 (COVID-19) RdRp gene [Presence] in Specimen by NAA with probe detection
LOINC	94315-9	SARS-related coronavirus E gene [Presence] in Specimen by NAA with probe detection
LOINC	94316-7	SARS-CoV-2 (COVID-19) N gene [Presence] in Specimen by NAA with probe detection
LOINC	94500-6	SARS-CoV-2 (COVID-19) RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	94533-7	SARS-CoV-2 (COVID-19) N gene [Presence] in Respiratory specimen by NAA with probe detection
LOINC	94534-5	SARS-CoV-2 (COVID-19) RdRp gene [Presence] in Respiratory specimen by NAA with probe detection
LOINC	94558-4	SARS-CoV-2 (COVID-19) Ag [Presence] in Respiratory specimen by Rapid immunoassay
LOINC	94559-2	SARS-CoV-2 (COVID-19) ORF1ab region [Presence] in Respiratory specimen by NAA with probe detection
LOINC	94642-6	SARS-CoV-2 (COVID-19) S gene [Cycle Threshold #] in Respiratory specimen by NAA with probe detection
LOINC	94643-4	SARS-CoV-2 (COVID-19) S gene [Cycle Threshold #] in Specimen by NAA with probe detection
LOINC	94644-2	SARS-CoV-2 (COVID-19) ORF1ab region [Cycle Threshold #] in Respiratory specimen by NAA with probe detection
LOINC	94645-9	SARS-CoV-2 (COVID-19) RdRp gene [Cycle Threshold #] in Specimen by NAA with probe detection
LOINC	94646-7	SARS-CoV-2 (COVID-19) RdRp gene [Cycle Threshold #] in Respiratory specimen by NAA with probe detection
LOINC	94759-8	SARS-CoV-2 (COVID-19) RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	95522-9	SARS-CoV-2 (COVID-19) N gene [Log #/volume] (viral load) in Respiratory specimen by NAA with probe detection
LOINC	94311-8	SARS-CoV-2 (COVID-19) N gene [Cycle Threshold #] in Specimen by Nucleic acid amplification using CDC primer-probe set N1

Code System	Concept Code	Concept Name
LOINC	94312-6	SARS-CoV-2 (COVID-19) N gene [Cycle Threshold #] in Specimen by Nucleic acid amplification using CDC primer-probe set N2
LOINC	94313-4	SARS-like coronavirus N gene [Cycle Threshold #] in Specimen by NAA with probe detection
LOINC	94509-7	SARS-related coronavirus E gene [Cycle Threshold #] in Specimen by NAA with probe detection
LOINC	94510-5	SARS-CoV-2 (COVID-19) N gene [Cycle Threshold #] in Specimen by NAA with probe detection
LOINC	94511-3	SARS-CoV-2 (COVID-19) ORF1ab region [Cycle Threshold #] in Specimen by NAA with probe detection
LOINC	94639-2	SARS-CoV-2 (COVID-19) ORF1ab region [Presence] in Specimen by NAA with probe detection
LOINC	94641-8	SARS-CoV-2 (COVID-19) S gene [Presence] in Specimen by NAA with probe detection
LOINC	94647-5	SARS-related coronavirus RNA [Presence] in Specimen by NAA with probe detection
LOINC	94746-5	SARS-CoV-2 (COVID-19) RNA [Cycle Threshold #] in Specimen by NAA with probe detection
LOINC	94819-0	SARS-CoV-2 (COVID-19) RNA [Log #/volume] (viral load) in Specimen by NAA with probe detection

Table S1: LOINC Codes for COVID lab test

Table S2: LOINC codes for human metapneumovirus lab test

Code System	Concept Code	Concept Name
LOINC	60425-6	Human metapneumovirus Ag [Presence] in Specimen
LOINC	88222-5	Human metapneumovirus Ag [Presence] in Nasopharynx by Immunofluorescence
LOINC	91810-2	Human metapneumovirus Ag [Presence] in Upper respiratory specimen by Immunofluorescence
LOINC	91831-8	Human metapneumovirus Ag [Presence] in Lower respiratory specimen by Immunofluorescence
LOINC	40979-7	Human metapneumovirus Ag [Presence] in Specimen by Immunofluorescence
LOINC	60266-4	Human metapneumovirus RNA [Presence] in Isolate by NAA with probe detection
LOINC	67820-1	Human metapneumovirus A RNA [Presence] in Specimen by NAA with probe detection
LOINC	67821-9	Human metapneumovirus B RNA [Presence] in Specimen by NAA with probe detection
LOINC	77024-8	Human metapneumovirus RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	82165-2	Human metapneumovirus RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	88534-3	Human metapneumovirus RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	89651-4	Human metapneumovirus RNA [Presence] in Lower respiratory specimen by NAA with probe detection

Code System	Concept Code	Concept Name
LOINC	91809-4	Human metapneumovirus RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92134-6	Human metapneumovirus RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	92978-6	Human metapneumovirus RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	38917-1	Human metapneumovirus RNA [Presence] in Specimen by NAA with probe detection
LOINC	40978-9	Human metapneumovirus RNA [Identifier] in Specimen by NAA with probe detection

Table S2: LOINC Codes for human metapneumovirus lab test

Table S3: LOINC codes for influenza lab test

Code System	Concept Code	Concept Name
LOINC	49522-6	Influenza virus A H3 Ag [Presence] in Isolate by Immunofluorescence
LOINC	49529-1	Influenza virus A Ag [Presence] in Isolate by Immunofluorescence
LOINC	49534-1	Influenza virus B Ag [Presence] in Isolate by Immunofluorescence
LOINC	50701-2	Influenza virus A H1 Ag [Presence] in Isolate by Immunofluorescence
LOINC	54240-7	Influenza virus Ag [Presence] in Specimen
LOINC	54241-5	Influenza virus B Ag [Presence] in Isolate
LOINC	72367-6	Influenza virus A+B Ag [Presence] in Nose by Rapid immunoassay
LOINC	77383-8	Influenza virus A Ag [Presence] in Bronchoalveolar lavage by Immunofluorescence
LOINC	77384-6	Influenza virus B Ag [Presence] in Bronchoalveolar lavage by Immunofluorescence
LOINC	80382-5	Influenza virus A Ag [Presence] in Nasopharynx by Rapid immunoassay
LOINC	80383-3	Influenza virus B Ag [Presence] in Nasopharynx by Rapid immunoassay
LOINC	85821-7	Influenza virus B Victoria lineage Ag [Presence] in Isolate by Hemagglutination inhibition
LOINC	86318-3	Influenza virus B Yamagata lineage Ag [Presence] in Isolate by Hemagglutination inhibition
LOINC	86565-9	Influenza virus A Ag [Presence] in Tissue by Immunofluorescence
LOINC	88194-6	Influenza virus B Ag [Presence] in Tissue by Immunofluorescence
LOINC	88904-8	Influenza virus A Ag [Presence] in Lower respiratory specimen by Immunofluorescence
LOINC	88905-5	Influenza virus B Ag [Presence] in Lower respiratory specimen by Immunofluorescence
LOINC	5860-2	Influenza virus A Ag [Presence] in Throat by Immunoassay
LOINC	5861-0	Influenza virus A Ag [Presence] in Throat by Immunofluorescence

Code System	Concept Code	Concept Name
LOINC	5862-8	Influenza virus A Ag [Presence] in Specimen by Immunoassay
LOINC	5863-6	Influenza virus A Ag [Presence] in Specimen by Immunofluorescence
LOINC	5864-4	Influenza virus B Ag [Presence] in Throat by Immunoassay
LOINC	5865-1	Influenza virus B Ag [Presence] in Throat by Immunofluorescence
LOINC	5866-9	Influenza virus B Ag [Presence] in Specimen by Immunoassay
LOINC	5867-7	Influenza virus B Ag [Presence] in Specimen by Immunofluorescence
LOINC	6435-2	Influenza virus A+B Ag [Presence] in Throat by Immunoassay
LOINC	6436-0	Influenza virus A+B Ag [Presence] in Throat by Immunofluorescence
LOINC	6437-8	Influenza virus A+B Ag [Presence] in Specimen by Immunoassay
LOINC	6438-6	Influenza virus A+B Ag [Presence] in Specimen by Immunofluorescence
LOINC	6439-4	Influenza virus A+B+C Ag [Presence] in Throat by Immunoassay
LOINC	6440-2	Influenza virus A+B+C Ag [Presence] in Throat by Immunofluorescence
LOINC	6441-0	Influenza virus A+B+C Ag [Presence] in Specimen by Immunoassay
LOINC	6442-8	Influenza virus A+B+C Ag [Presence] in Specimen by Immunofluorescence
LOINC	22825-4	Influenza virus A Ag [Presence] in Specimen by Immune diffusion (ID)
LOINC	24015-0	Influenza virus A+B Ag [Presence] in Specimen
LOINC	29721-8	Influenza virus C Ag [Presence] in Specimen by Immunofluorescence
LOINC	31858-4	Influenza virus A Ag [Presence] in Throat
LOINC	31859-2	Influenza virus A Ag [Presence] in Specimen
LOINC	31860-0	Influenza virus A+B Ag [Presence] in Throat
LOINC	31861-8	Influenza virus A+B+C Ag [Presence] in Throat
LOINC	31862-6	Influenza virus A+B+C Ag [Presence] in Specimen
LOINC	31863-4	Influenza virus B Ag [Presence] in Throat
LOINC	31864-2	Influenza virus B Ag [Presence] in Specimen
LOINC	31865-9	Influenza virus C Ag [Presence] in Specimen
LOINC	33535-6	Influenza virus A+B Ag [Presence] in Nasopharynx
LOINC	43874-7	Influenza virus A Ag [Presence] in Nasopharynx
LOINC	43895-2	Influenza virus B Ag [Presence] in Nasopharynx
LOINC	44558-5	Influenza virus A Ag [Presence] in Nasopharynx by Immunofluorescence

Code System	Concept Code	Concept Name
LOINC	44559-3	Influenza virus A Ag [Presence] in Bronchial specimen by Immunofluorescence
LOINC	44560-1	Influenza virus A Ag [Presence] in Nose by Immunofluorescence
LOINC	44561-9	Influenza virus A Ag [Presence] in Trachea by Immunofluorescence
LOINC	44562-7	Influenza virus A Ag [Presence] in Bronchial specimen
LOINC	44563-5	Influenza virus A Ag [Presence] in Nose
LOINC	44564-3	Influenza virus A Ag [Presence] in Nose by Immunoassay
LOINC	44566-8	Influenza virus A+B Ag [Presence] in Bronchial specimen
LOINC	44567-6	Influenza virus A+B Ag [Presence] in Nose
LOINC	44571-8	Influenza virus B Ag [Presence] in Nasopharynx by Immunofluorescence
LOINC	44572-6	Influenza virus B Ag [Presence] in Bronchial specimen by Immunofluorescence
LOINC	44573-4	Influenza virus B Ag [Presence] in Nose by Immunofluorescence
LOINC	44574-2	Influenza virus B Ag [Presence] in Trachea by Immunofluorescence
LOINC	44575-9	Influenza virus B Ag [Presence] in Nose by Immunoassay
LOINC	44576-7	Influenza virus B Ag [Presence] in Bronchial specimen
LOINC	44577-5	Influenza virus B Ag [Presence] in Nose
LOINC	46082-4	Influenza virus A Ag [Presence] in Nasopharynx by Immunoassay
LOINC	46083-2	Influenza virus B Ag [Presence] in Nasopharynx by Immunoassay
LOINC	100343-3	Influenza virus B RNA [Presence] in Saliva (oral fluid) by NAA with probe detection
LOINC	100344-1	Influenza virus A RNA [Presence] in Saliva (oral fluid) by NAA with probe detection
LOINC	49520-0	Influenza virus A H1 RNA [Presence] in Isolate by NAA with probe detection
LOINC	49521-8	Influenza virus A H1 RNA [Presence] in Specimen by NAA with probe detection
LOINC	49523-4	Influenza virus A H3 RNA [Presence] in Isolate by NAA with probe detection
LOINC	49524-2	Influenza virus A H3 RNA [Presence] in Specimen by NAA with probe detection
LOINC	49526-7	Influenza virus A H5 RNA [Presence] in Isolate by NAA with probe detection
LOINC	49527-5	Influenza virus A H7 RNA [Presence] in Isolate by NAA with probe detection
LOINC	49528-3	Influenza virus A H9 RNA [Presence] in Specimen by NAA with probe detection
LOINC	49531-7	Influenza virus A RNA [Presence] in Isolate by NAA with probe detection
LOINC	49535-8	Influenza virus B RNA [Presence] in Isolate by NAA with probe detection
LOINC	50700-4	Influenza virus A.adamantane resistant RNA [Presence] by NAA with probe detection

Code System	Concept Code	Concept Name
LOINC	50702-0	Influenza virus A matrix protein RNA [Presence] in Isolate by Sequencing
LOINC	50704-6	Influenza virus A nucleoprotein RNA [Presence] in Isolate by Sequencing
LOINC	50705-3	Influenza virus A non-structural protein RNA [Presence] in Isolate by Sequencing
LOINC	50706-1	Influenza virus A polymerase A RNA [Presence] in Isolate by Sequencing
LOINC	50708-7	Influenza virus A polymerase B2 RNA [Presence] in Isolate by Sequencing
LOINC	57985-4	Influenza virus A H2 RNA [Presence] in Specimen by NAA with probe detection
LOINC	60267-2	Influenza virus C RNA [Presence] in Isolate by NAA with probe detection
LOINC	60530-3	Influenza virus A H9 RNA [Presence] in Isolate by NAA with probe detection
LOINC	60538-6	Influenza virus A H1+H3+B RNA [Presence] in Specimen by NAA with probe detection
LOINC	62462-7	Influenza virus A+B RNA [Presence] in Specimen by NAA with probe detection
LOINC	62860-2	Influenza virus C RNA [Presence] in Specimen by NAA with probe detection
LOINC	68986-9	Influenza virus A H5a RNA [Presence] in Specimen by NAA with probe detection
LOINC	68987-7	Influenza virus A H5b RNA [Presence] in Specimen by NAA with probe detection
LOINC	74785-7	Influenza virus B Victoria lineage RNA [Presence] in Specimen by NAA with probe detection
LOINC	74786-5	Influenza virus B Yamagata lineage RNA [Presence] in Specimen by NAA with probe detection
LOINC	76077-7	Influenza virus A RNA [Presence] in Bronchoalveolar lavage by NAA with probe detection
LOINC	76078-5	Influenza virus A RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	76079-3	Influenza virus B RNA [Presence] in Bronchoalveolar lavage by NAA with probe detection
LOINC	76080-1	Influenza virus B RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	77026-3	Influenza virus A H1 RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	77027-1	Influenza virus A H3 RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	81428-5	Influenza virus A H7 Eurasia RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	82166-0	Influenza virus A RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	82167-8	Influenza virus A H1 RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	82169-4	Influenza virus A H3 RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	82170-2	Influenza virus B RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	85477-8	Influenza virus A RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	85478-6	Influenza virus B RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	86568-3	Influenza virus A RNA [Presence] in Cerebral spinal fluid by NAA with probe detection

Code System	Concept Code	Concept Name
LOINC	86569-1	Influenza virus A RNA [Presence] in Tissue by NAA with probe detection
LOINC	86571-7	Influenza virus B RNA [Presence] in Cerebral spinal fluid by NAA with probe detection
LOINC	86572-5	Influenza virus B RNA [Presence] in Tissue by NAA with probe detection
LOINC	88193-8	Influenza virus A RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88195-3	Influenza virus B RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88592-1	Influenza virus B RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88596-2	Influenza virus B RNA [Presence] in Pericardial fluid by NAA with probe detection
LOINC	88599-6	Influenza virus A RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88600-2	Influenza virus A RNA [Presence] in Pericardial fluid by NAA with probe detection
LOINC	92141-1	Influenza virus B RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	92142-9	Influenza virus A RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	92808-5	Influenza virus A H3 RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92809-3	Influenza virus A H1 RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92976-0	Influenza virus B RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	92977-8	Influenza virus A RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	94394-4	Influenza virus A H3 RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	94396-9	Influenza virus A H1 RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	95658-1	Influenza virus A H7 Eurasia RNA [Presence] in Specimen by NAA with probe detection
LOINC	99623-1	Influenza virus A N1 RNA [Presence] in Specimen by NAA with probe detection
LOINC	34487-9	Influenza virus A RNA [Presence] in Specimen by NAA with probe detection
LOINC	38270-5	Influenza virus A H7 RNA [Presence] in Specimen by NAA with probe detection
LOINC	38271-3	Influenza virus A H6 RNA [Presence] in Specimen by NAA with probe detection
LOINC	38272-1	Influenza virus A H5 RNA [Presence] in Specimen by NAA with probe detection
LOINC	40981-3	Deprecated Influenza virus A RNA [Presence] in Unspecified specimen by Probe & target amplification method
LOINC	40982-1	Influenza virus B RNA [Presence] in Specimen by NAA with probe detection
LOINC	44091-7	Deprecated Influenza virus A hemagglutinin H5 RNA [Presence] in Unspecified specimen by Probe & target amplification method
LOINC	44795-3	Influenza virus A H5 Asian RNA [Presence] in Specimen by NAA with probe detection
LOINC	72366-8	Influenza virus A and B Ag [Identifier] in Nose by Rapid immunoassay

Code System	Concept Code	Concept Name
LOINC	76078-5	Influenza virus A RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	92142-9	Influenza virus A RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	5229-0	Influenza virus A Ab [Titer] in Serum by Complement fixation
LOINC	5230-8	Influenza virus B Ab [Titer] in Serum by Complement fixation
LOINC	5862-8	Influenza virus A Ag [Presence] in Specimen by Immunoassay
LOINC	43895-2	Influenza virus B Ag [Presence] in Nasopharynx
LOINC	48310-7	Influenza virus A [Presence] in Specimen by Organism specific culture
LOINC	48509-4	Influenza virus A and B RNA [Identifier] in Specimen by NAA with probe detection

Table S3: LOINC Codes for influenza lab test

Table S4: LOINC codes for parainfluenza virus lab test

Code System	Concept Code	Concept Name
LOINC	60424-9	Parainfluenza virus 4 Ag [Presence] in Specimen
LOINC	67808-6	Parainfluenza virus 1 Ag [Presence] in Isolate by Immunofluorescence
LOINC	67809-4	Parainfluenza virus 2 Ag [Presence] in Isolate by Immunofluorescence
LOINC	67810-2	Parainfluenza virus 3 Ag [Presence] in Isolate by Immunofluorescence
LOINC	67811-0	Parainfluenza virus 4 Ag [Presence] in Isolate by Immunofluorescence
LOINC	77385-3	Parainfluenza virus 1 Ag [Presence] in Bronchoalveolar lavage by Immunofluorescence
LOINC	77386-1	Parainfluenza virus 2 Ag [Presence] in Bronchoalveolar lavage by Immunofluorescence
LOINC	77387-9	Parainfluenza virus 3 Ag [Presence] in Bronchoalveolar lavage by Immunofluorescence
LOINC	77391-1	Parainfluenza virus 2 Ag [Presence] in Nasopharynx by Immunofluorescence
LOINC	77392-9	Parainfluenza virus 3 Ag [Presence] in Nasopharynx by Immunofluorescence
LOINC	88906-3	Parainfluenza virus 1 Ag [Presence] in Lower respiratory specimen by Immunofluorescence
LOINC	88907-1	Parainfluenza virus 2 Ag [Presence] in Lower respiratory specimen by Immunofluorescence
LOINC	88908-9	Parainfluenza virus 3 Ag [Presence] in Lower respiratory specimen by Immunofluorescence
LOINC	5868-5	Parainfluenza virus 1 Ag [Presence] in Throat by Immunofluorescence
LOINC	5869-3	Parainfluenza virus 1 Ag [Presence] in Specimen by Immunofluorescence
LOINC	5870-1	Parainfluenza virus 2 Ag [Presence] in Throat by Immunofluorescence
LOINC	5871-9	Parainfluenza virus 2 Ag [Presence] in Specimen by Immunofluorescence

Code System	Concept Code	Concept Name
LOINC	5872-7	Parainfluenza virus 3 Ag [Presence] in Throat by Immunofluorescence
LOINC	5873-5	Parainfluenza virus 3 Ag [Presence] in Specimen by Immunofluorescence
LOINC	13327-2	Parainfluenza virus Ag [Presence] in Specimen by Immunofluorescence
LOINC	17414-4	Parainfluenza virus 1+2+3 Ag [Presence] in Specimen
LOINC	23678-6	Bovine parainfluenza virus 3 Ag [Presence] in Tissue by Immunofluorescence
LOINC	23699-2	Canine parainfluenza virus 2 Ag [Presence] in Tissue by Immunofluorescence
LOINC	31923-6	Parainfluenza virus 1 Ag [Presence] in Throat
LOINC	31924-4	Parainfluenza virus 1 Ag [Presence] in Specimen
LOINC	31925-1	Parainfluenza virus 2 Ag [Presence] in Throat
LOINC	31926-9	Parainfluenza virus 2 Ag [Presence] in Specimen
LOINC	31927-7	Parainfluenza virus 3 Ag [Presence] in Throat
LOINC	31928-5	Parainfluenza virus 3 Ag [Presence] in Specimen
LOINC	31929-3	Parainfluenza virus Ag [Presence] in Specimen
LOINC	38395-0	Parainfluenza virus 1 Ag [Presence] in Nasopharynx by Immunofluorescence
LOINC	38396-8	Parainfluenza virus 1 Ag [Presence] in Nose by Immunofluorescence
LOINC	40986-2	Parainfluenza virus 4 Ag [Presence] in Specimen by Immunofluorescence
LOINC	60254-0	Parainfluenza virus 1+2+3 RNA [Presence] in Specimen by NAA with probe detection
LOINC	60269-8	Parainfluenza virus 1 RNA [Presence] in Isolate by NAA with probe detection
LOINC	60415-7	Parainfluenza virus 4 RNA [Presence] in Isolate by NAA with probe detection
LOINC	60416-5	Parainfluenza virus 3 RNA [Presence] in Isolate by NAA with probe detection
LOINC	60417-3	Parainfluenza virus 2 RNA [Presence] in Isolate by NAA with probe detection
LOINC	61365-3	Parainfluenza virus RNA [Presence] in Specimen by NAA with probe detection
LOINC	67818-5	Parainfluenza virus 4a RNA [Presence] in Specimen by NAA with probe detection
LOINC	67819-3	Parainfluenza virus 4b RNA [Presence] in Specimen by NAA with probe detection
LOINC	76084-3	Parainfluenza virus 1 RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	76085-0	Parainfluenza virus 2 RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	76086-8	Parainfluenza virus 3 RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	76087-6	Parainfluenza virus 4 RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	82171-0	Parainfluenza virus 1 RNA [Presence] in Nasopharynx by NAA with non-probe detection

Code System	Concept Code	Concept Name
LOINC	82172-8	Parainfluenza virus 2 RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	82173-6	Parainfluenza virus 3 RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	82174-4	Parainfluenza virus 4 RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	87387-7	Porcine parainfluenza virus 1 RNA [Presence] in Specimen by NAA with probe detection
LOINC	88208-4	Parainfluenza virus 1 RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88209-2	Parainfluenza virus 2 RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88210-0	Parainfluenza virus 3 RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88529-3	Parainfluenza virus RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88530-1	Parainfluenza virus 4 RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88559-0	Parainfluenza virus 2 RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88560-8	Parainfluenza virus 3 RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88561-6	Parainfluenza virus 4 RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88562-4	Parainfluenza virus RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88563-2	Parainfluenza virus 1 RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88890-9	Parainfluenza virus 1+2+3+4 RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	91798-9	Parainfluenza virus RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	91799-7	Parainfluenza virus 4 RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	91800-3	Parainfluenza virus 3 RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	91801-1	Parainfluenza virus 2 RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	91802-9	Parainfluenza virus 1 RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92137-9	Parainfluenza virus 4 RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	92138-7	Parainfluenza virus 3 RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	92139-5	Parainfluenza virus 2 RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	92140-3	Parainfluenza virus 1 RNA [Presence] in Respiratory specimen by NAA with probe detection

Code System	Concept Code	Concept Name
LOINC	92883-8	Parainfluenza virus 1+2+3+4 RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	92884-6	Parainfluenza virus 1+2+3+4 RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92963-8	Parainfluenza virus RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	94483-5	Parainfluenza virus 1 RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	94484-3	Parainfluenza virus 2 RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	94485-0	Parainfluenza virus 3 RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	94486-8	Parainfluenza virus 4 RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	97645-6	Parainfluenza virus 1+2+3+4 RNA [Presence] in Specimen by NAA with probe detection
LOINC	29908-1	Parainfluenza virus 1 RNA [Presence] in Specimen by NAA with probe detection
LOINC	29909-9	Parainfluenza virus 2 RNA [Presence] in Specimen by NAA with probe detection
LOINC	29910-7	Parainfluenza virus 3 RNA [Presence] in Specimen by NAA with probe detection
LOINC	41010-0	Parainfluenza virus 4 RNA [Presence] in Specimen by NAA with probe detection
LOINC	55097-0	Parainfluenza virus 1 [Presence] in Specimen by Organism specific culture
LOINC	55098-8	Parainfluenza virus 2 [Presence] in Specimen by Organism specific culture
LOINC	55099-6	Parainfluenza virus 3 [Presence] in Specimen by Organism specific culture

Table S4: LOINC Codes for parainfluenza virus lab test

Table S7: LOINC codes for rhinovirus lab test

Code System	Concept Code	Concept Name
LOINC	40992-0	Rhinovirus+Enterovirus Ag [Presence] in Specimen by Immunofluorescence
LOINC	77025-5	Rhinovirus RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	80596-0	Rhinovirus 5' UTR RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	82175-1	Rhinovirus+Enterovirus RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	88213-4	Rhinovirus RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88721-6	Rhinovirus+Enterovirus RNA [Presence] in Nasopharynx by NAA with probe detection

Code System	Concept Code	Concept Name
LOINC	91131-3	Rhinovirus RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	91793-0	Rhinovirus RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92130-4	Rhinovirus RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	92807-7	Rhinovirus+Enterovirus RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92885-3	Rhinovirus+Enterovirus RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	92956-2	Rhinovirus+Enterovirus RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	97954-2	Rhinovirus+Enterovirus A+B+C RNA [Presence] in Respiratory specimen by NAA with probe detection
LOINC	7993-9	Rhinovirus RNA [Presence] in Specimen by NAA with probe detection
LOINC	40991-2	Rhinovirus+Enterovirus RNA [Presence] in Specimen by NAA with probe detection

Table S7: LOINC Codes for rhinovirus lab test

Table S5: LOINC codes for RSV lab test

Code System	Concept Code	Concept Name
LOINC	50329-2	Respiratory syncytial virus Ag [Presence] in Tissue by Immune stain
LOINC	68966-1	Respiratory syncytial virus Ag [Presence] in Nasopharynx by Immunoassay
LOINC	72885-7	Respiratory syncytial virus Ag [Presence] in Nasopharynx by Rapid immunoassay
LOINC	77389-5	Respiratory syncytial virus Ag [Presence] in Bronchoalveolar lavage by Immunofluorescence
LOINC	77390-3	Respiratory syncytial virus Ag [Presence] in Nasopharynx by Immunofluorescence
LOINC	88909-7	Respiratory syncytial virus Ag [Presence] in Lower respiratory specimen by Immunofluorescence
LOINC	94613-7	Bovine respiratory syncytial virus Ag [Presence] in Tissue by Immune stain
LOINC	5874-3	Respiratory syncytial virus Ag [Presence] in Throat by Immunoassay
LOINC	5875-0	Respiratory syncytial virus Ag [Presence] in Throat by Immunofluorescence
LOINC	5876-8	Respiratory syncytial virus Ag [Presence] in Specimen by Immunoassay
LOINC	5877-6	Respiratory syncytial virus Ag [Presence] in Specimen by Immunofluorescence
LOINC	20943-7	Bovine respiratory syncytial virus Ag [Presence] in Lung by Immune stain
LOINC	20944-5	Bovine respiratory syncytial virus Ag [Presence] in Lung by Immunoassay
LOINC	20945-2	Bovine respiratory syncytial virus Ag [Presence] in Lung by Immunofluorescence

Code System	Concept Code	Concept Name
LOINC	23679-4	Bovine respiratory syncytial virus Ag [Presence] in Specimen
LOINC	31751-1	Bovine respiratory syncytial virus Ag [Presence] in Lung
LOINC	31949-1	Respiratory syncytial virus Ag [Presence] in Throat
LOINC	31950-9	Respiratory syncytial virus Ag [Presence] in Specimen
LOINC	32040-8	Respiratory syncytial virus Ag [Presence] in Nose by Immunofluorescence
LOINC	33045-6	Respiratory syncytial virus Ag [Presence] in Nose
LOINC	60271-4	Respiratory syncytial virus RNA [Presence] in Isolate by NAA with probe detection
LOINC	76088-4	Respiratory syncytial virus RNA [Presence] in Bronchoalveolar lavage by NAA with probe detection
LOINC	76089-2	Respiratory syncytial virus RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	77022-2	Respiratory syncytial virus A RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	77023-0	Respiratory syncytial virus B RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	80597-8	Respiratory syncytial virus A 5' UTR RNA [Presence] in Nasopharynx by NAA with probe detection
LOINC	82176-9	Respiratory syncytial virus RNA [Presence] in Nasopharynx by NAA with non-probe detection
LOINC	85479-4	Respiratory syncytial virus RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	88202-7	Respiratory syncytial virus B RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88204-3	Respiratory syncytial virus A RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88528-5	Respiratory syncytial virus RNA [Presence] in Cornea or Conjunctiva by NAA with probe detection
LOINC	88595-4	Respiratory syncytial virus A RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	88597-0	Respiratory syncytial virus B RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	91133-9	Respiratory syncytial virus RNA [Presence] in Lower respiratory specimen by NAA with probe detection
LOINC	91794-8	Respiratory syncytial virus B RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	91795-5	Respiratory syncytial virus A RNA [Presence] in Upper respiratory specimen by NAA with probe detection
LOINC	92131-2	Respiratory syncytial virus RNA [Presence] in Respiratory specimen by NAA with probe detection

Code System	Concept Code	Concept Name
LOINC	92957-0	Respiratory syncytial virus RNA [Presence] in Lower respiratory specimen by NAA with non-probe detection
LOINC	30075-6	Respiratory syncytial virus A RNA [Presence] in Specimen by NAA with probe detection
LOINC	30076-4	Respiratory syncytial virus B RNA [Presence] in Specimen by NAA with probe detection
LOINC	40988-8	Respiratory syncytial virus RNA [Presence] in Specimen by NAA with probe detection

Table S5: LOINC Codes for RSV lab test