Public Health Scotland

Community Acute Respiratory Infection (CARI) surveillance in primary care

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Contents

Introduction

National respiratory surveillance systems should be resilient and agile to address global and national surveillance needs for influenza and SARS-CoV-2, in order to monitor trends and maintain vigilance for future pandemics. The World Health Organization (WHO) has emphasised the importance of continued surveillance of influenza and other respiratory pathogens in the community, while integrating surveillance of COVID-19.[1,2]

The Community Acute Respiratory Infection (CARI) surveillance programme is an integrated sentinel community (primary care) surveillance programme for influenza, SARS-CoV-2 and other respiratory infections caused by respiratory syncytial virus (RSV), adenovirus, seasonal coronavirus (non-SARS-CoV-2), human metapneumovirus (HMPV), rhinovirus, parainfluenza and *mycoplasma pneumoniae*. It forms a key component of **Scotland's national infectious respiratory diseases plan**.

This report provides a summary of data from the CARI surveillance programme for the 2022/2023 respiratory season.

Main points

- A total of 11,833 samples from 139 recruited sentinel GP practices were tested as part of CARI surveillance during the 2022/2023 respiratory season. Of these, 4,049 (34.2%) had additional enhanced surveillance data available.
- Overall swab positivity for all respiratory pathogens was 55.9%. It was highest in the 0–4-year age group at 77.7% followed by the 5–17 age group at 60.2%.
- Swab positivity was significantly higher in males (60.0%) compared to females (53.5%).
- Overall swab positivity was similar across all Scottish Index of Multiple Deprivation (SIMD) quintiles.
- Swab positivity for all respiratory pathogens was highest in NHS Fife at 64.2% followed by NHS Western Isles at 61.1%.
- Rhinovirus was the highest circulating pathogen during the surveillance period (swab positivity at 19.0%), followed by influenza A (swab positivity at 13.7%), and respiratory syncytial virus (RSV) and seasonal coronavirus (swab positivity at 6.1% for both).
- Cough was the most common symptom in all patients presenting with respiratory symptoms and recruited for CARI surveillance.
- There was an association between cough and swab positivity for HMPV, seasonal coronavirus, RSV, and influenza A. Runny/blocked nose and sneezing were associated with most respiratory pathogens, apart from SARS-CoV-2, adenovirus, parainfluenza, and influenza B. No symptoms showed specific associations for SARS-CoV-2 and parainfluenza. All symptoms showed an association with influenza A apart from diarrhoea and sore throat.
- Overall influenza vaccine effectiveness in the entire sample of fully vaccinated patients enrolled in CARI surveillance was 43.4% for those aged 18–64 years and 46.9% for those aged 65 years or over.

Objectives

The objectives of the CARI programme are:

- To estimate disease burden and overall impact of acute respiratory infection (ARI) in the community.
- To provide early detection of community transmission of respiratory pathogens.
- To monitor co-circulation of respiratory pathogens.
- To provide descriptive epidemiology of cases of ARI and to identify and monitor groups at high risk of severe disease and mortality.
- To describe trends and seasonal patterns in respiratory activity.
- To establish historic levels of activity for respiratory illness to enable evaluation of the impact and severity of each seasonal/epidemic period.
- To provide samples for sequencing for variant detection and to monitor locally circulating virus types/subtypes or lineages/sub-lineages.
- To detect unusual and unexpected events such as outbreaks or clusters.
- To contribute to the evaluation of vaccine effectiveness.
- To inform the implementation and adjustment of targeted public health interventions.
- To create feedback for clinicians in a way that supports clinical improvement and understanding.

Methods

Full details of the methods used for CARI surveillance are outlined in the **CARI protocol**. In 2022/2023, surveillance took place in a network of sentinel GP practices across Scotland. Patients with acute respiratory symptoms who met the CARI case definition were recruited and swabbed. The swab was returned to the West of Scotland Specialist Virology Centre (WoSSVC) for multiplex PCR testing for a range of respiratory pathogens. Additional surveillance data were collected from patients via an online survey completed by patients at home, or by clinicians at the time of swabbing.

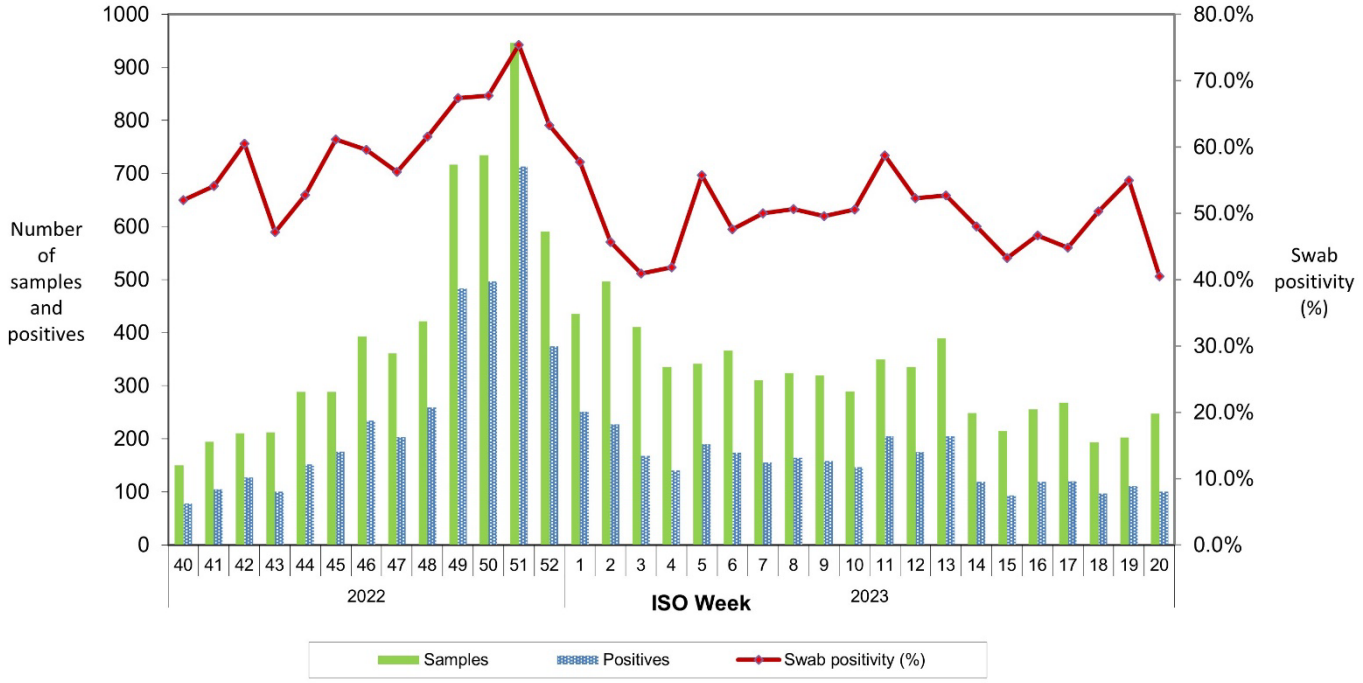
Analyses were carried out on CARI data collected between 3 October 2022 and 21 May 2023. The total numbers of swabs submitted, the total numbers of positive swabs and swab positivity (with 95% confidence intervals [CI]) were determined over time, and stratified by age, sex, Scottish Index of Multiple Deprivation (SIMD) quintile[3] and health board. This was then repeated for each pathogen separately, and compared with the **2021/2022 season** (note though that the time periods are not directly comparable as the 2021/2022 season analysis covered a wider reporting period from 1 November 2021 to 2 October 2022). Symptoms analysis was also carried out for each confirmed infection for the subset of swabs with enhanced surveillance data available (34.2%). Odds ratios (OR) (with 95% CI) represent the odds of reporting each symptom among cases (positive for that pathogen) versus controls (negative for that specific pathogen).

Results and commentary

Between 3 October 2022 (ISO week 40) and 21 May 2023 (ISO week 20), 11,833 samples were tested as part of the CARI programme. Figure 1 shows that the number of swabs submitted by GP practices steadily increased from week 40 to a peak of over 900 in week 51 (19 December 2022), then decreased thereafter to around 200–300 swabs per week. The increased swab submissions were likely to have been driven by increased consultations for ARI in primary care at a time of increased influenza A activity, and possibly also due to public concerns about invasive group A streptococcal infection (iGAS). iGAS is a rare complication of streptococcal infection which usually causes scarlet fever and can present with cold and influenza-like symptoms. In Scotland, **PHS was reporting an increasing number of cases of iGAS at this time**, and there were a number of deaths in the UK that were being widely reported in the media.

Overall swab positivity was 55.9%. Overall swab positivity fluctuated over time but was highest during the festive season between week 49 (5 December 2022) and week 51 (19 December 2022). This coincided with the peak winter respiratory season and was largely driven by influenza A activity.

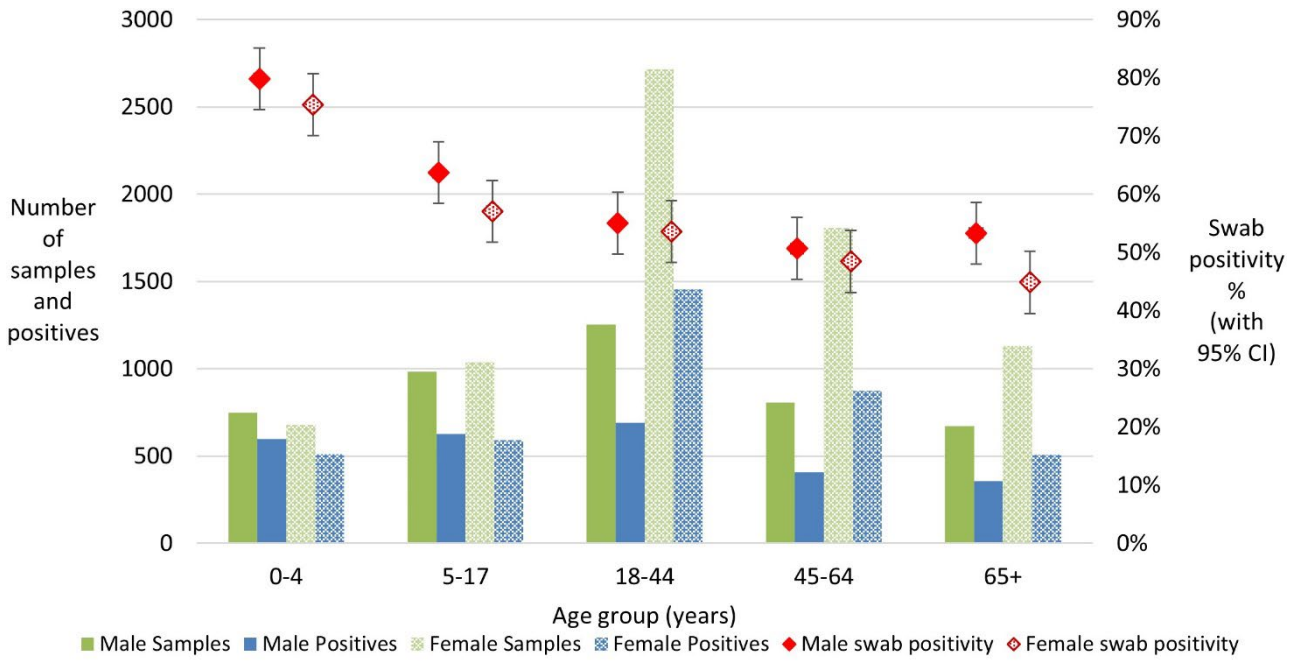
Figure 1: Numbers of samples, numbers of positive samples, and overall swab positivity over time (week 40, 2022 to week 20, 2023)



Swab positivity by age and sex

For all swabs submitted to week 20, overall swab positivity for all respiratory pathogens was highest in the 0–4-year age group at 77.7% (95% CI: 75.5 to 79.8). This was significantly higher than all other age groups, and was followed by swab positivity of 60.2% (95% CI: 58.1 to 62.4) in the 5–17 age group (Figure 2). Fewer swabs were submitted by males in all age groups except the 0–4 age group, and this could be due to the more proactive health-seeking behaviour of women.[4] Swab positivity was significantly higher for males overall at 60.0% (95% CI: 58.6 to 61.5) compared with females at 53.5% (95% CI: 52.3 to 54.6).

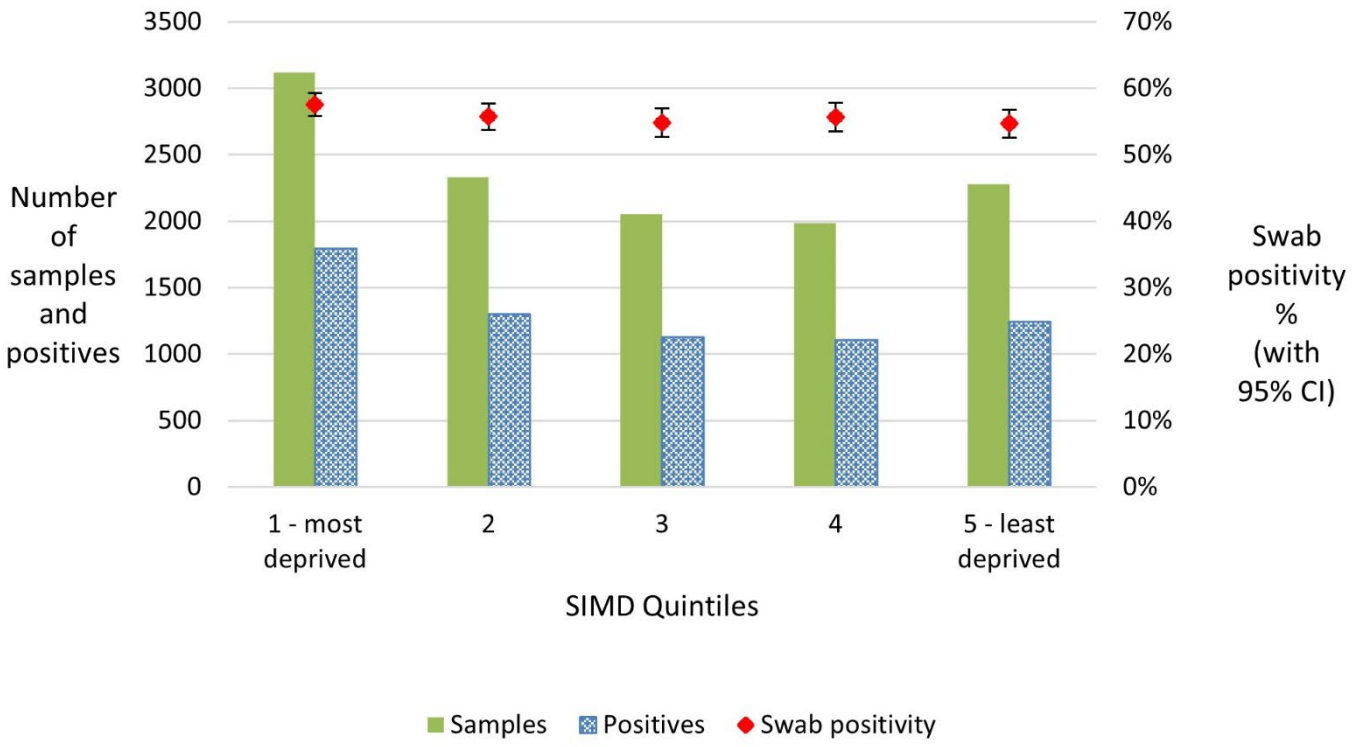
Figure 2: Numbers of samples and positive samples, and overall swab positivity by age and sex



Swab positivity by Scottish Index of Multiple Deprivation (SIMD)

Figure 3 shows that the highest number of swabs submitted were from SIMD1, the most deprived quintile. Overall swab positivity was similar across all SIMD quintiles.

Figure 3: Numbers of samples and positive samples, and overall swab positivity by SIMD quintile

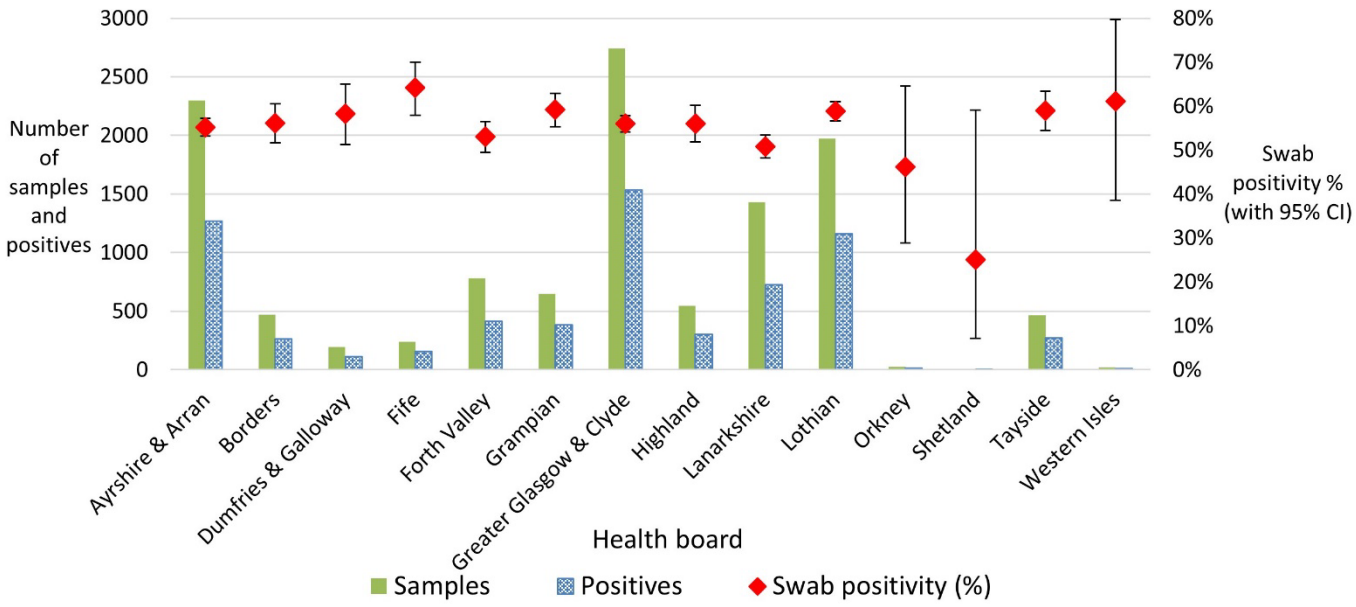


This pattern was similar for individual pathogens (data not shown).

Swab positivity by health board

The highest number of swabs were received by NHS Greater Glasgow & Clyde (which has the largest population) and the island boards submitted the fewest swabs. Overall swab positivity for all respiratory pathogens was highest in NHS Fife at 64.2% followed by NHS Western Isles at 61.1%, shown in Figure 4.

Figure 4: Number of samples and positive samples, and overall swab positivity by health board

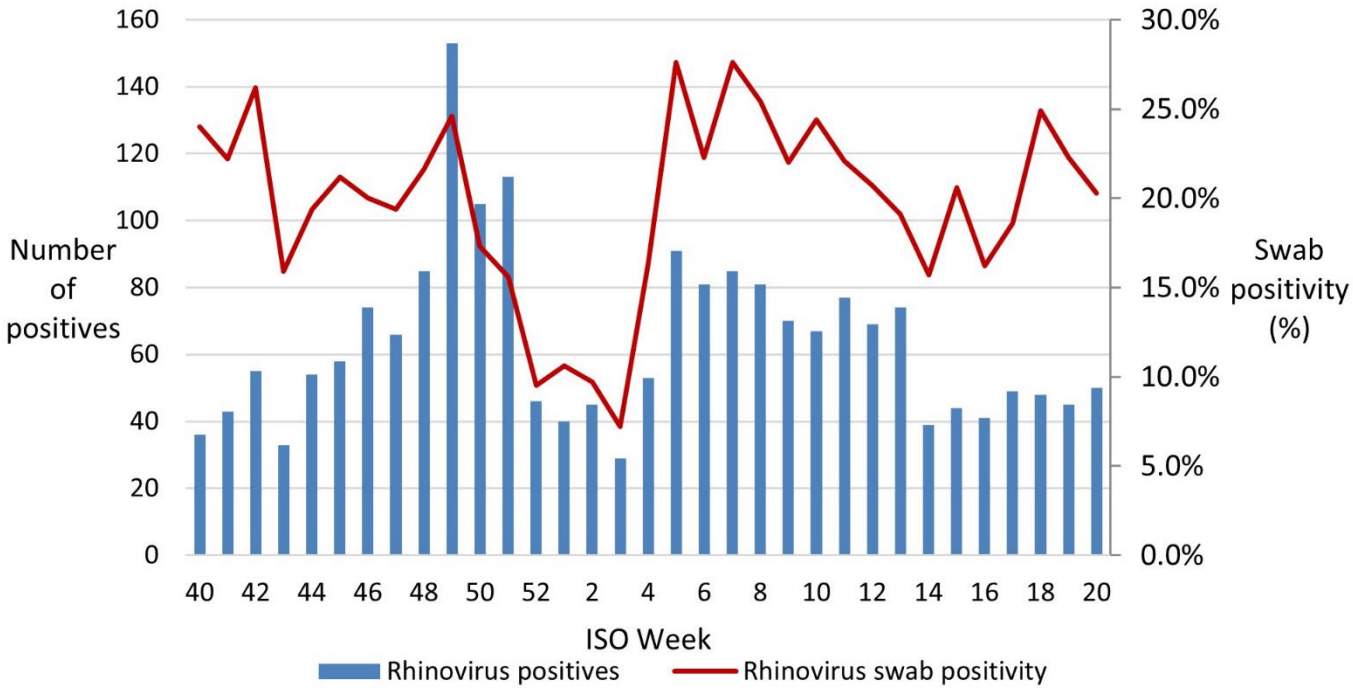


Analysis by pathogen

Rhinovirus

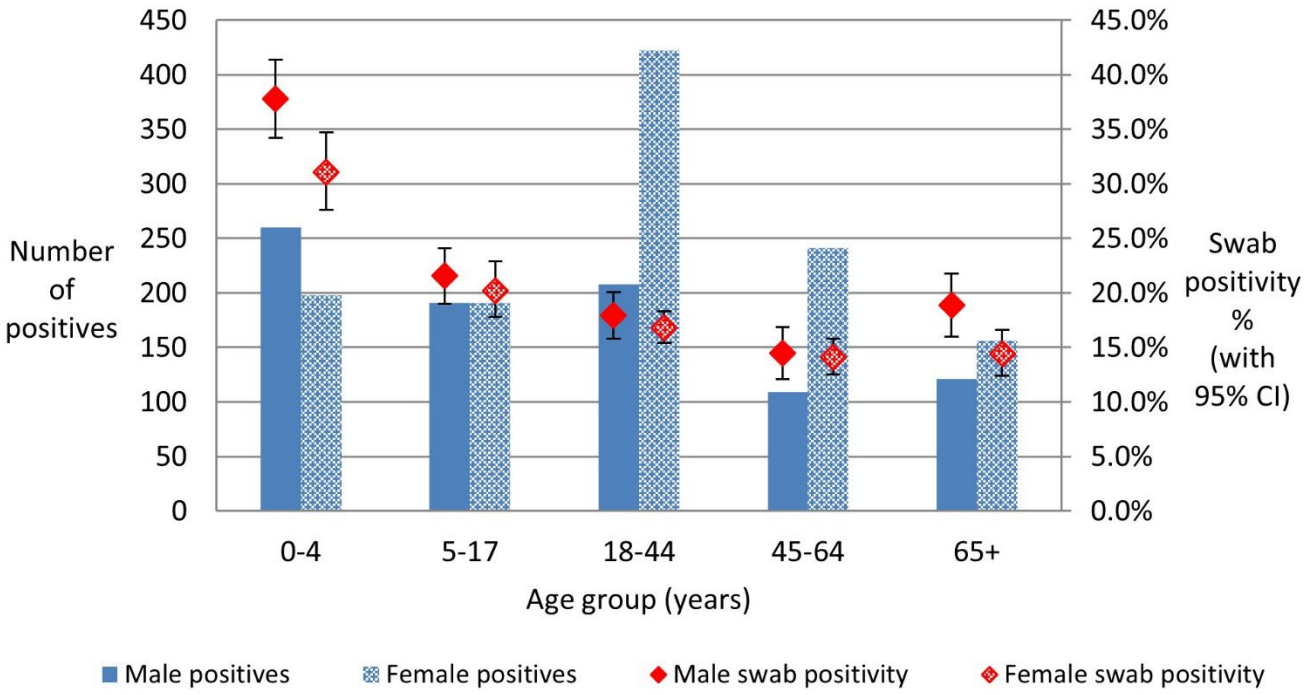
Rhinovirus was the highest circulating pathogen in the community between week 40 and week 48, and then again from week 04. This is not unusual as rhinovirus is the leading cause of common cold symptoms.[5] Overall swab positivity was 19.0% (95% CI: 18.3 to 19.8) which is lower than recorded for the **2021/2022 season** at 21.3%. There were a number of peaks seen throughout the season, with the highest swab positivity recorded for weeks 05 and 09, both at 27.6% (Figure 5). This coincides with the previous season 2021/2022, when swab positivity peaked around autumn, with smaller peaks around springtime, and was at its lowest around weeks 01 and 02.

Figure 5: Number of samples positive for rhinovirus and swab positivity over time (week 40, 2022 to week 20, 2023)



For all swabs submitted to week 20, overall swab positivity for rhinovirus was higher in males compared to females in all age groups. It was highest in the 0–4 age group: 37.8% (95% CI: 34.2 to 41.5) in males and 31.0% (95% CI: 27.6 to 34.7) in females, which was significantly higher than all other age groups. A high incidence in young children that declines with age is as expected for rhinovirus.[5]

Figure 6: Number of positive samples and swab positivity for rhinovirus by age and sex



Cough, followed by runny/blocked nose, fatigue and sore throat were the most common symptoms among patients testing positive for rhinovirus (Figure 7a), although only runny/blocked nose and sneezing were more likely to be reported by patients positive for rhinovirus compared with all other patients (Figure 7b). This aligns with recognised symptoms.[5] Loss of appetite, reporting of limb/joint pain, aching, headache and chills were negatively associated with testing positive for rhinovirus.

Figure 7a: Number of positive rhinovirus cases reporting symptoms

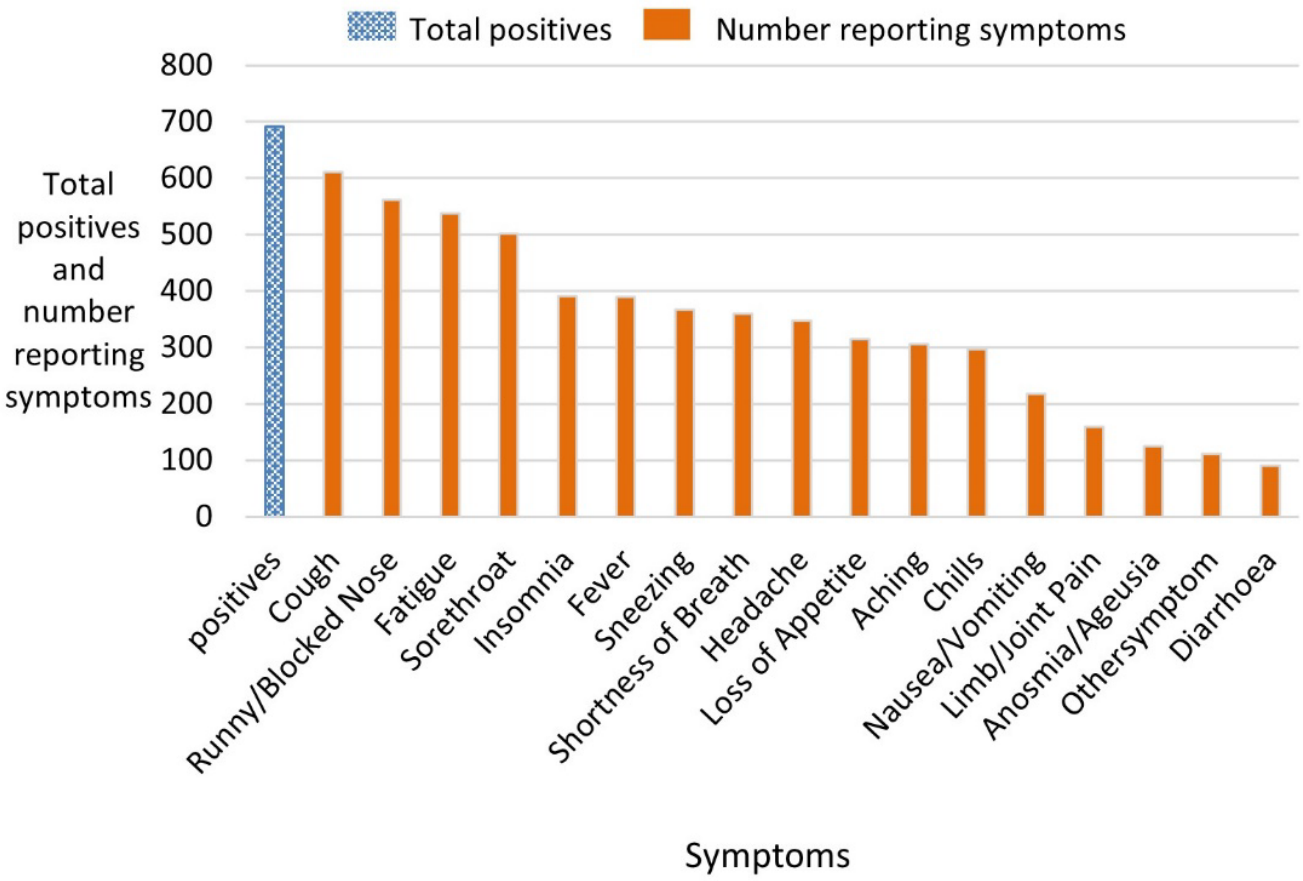
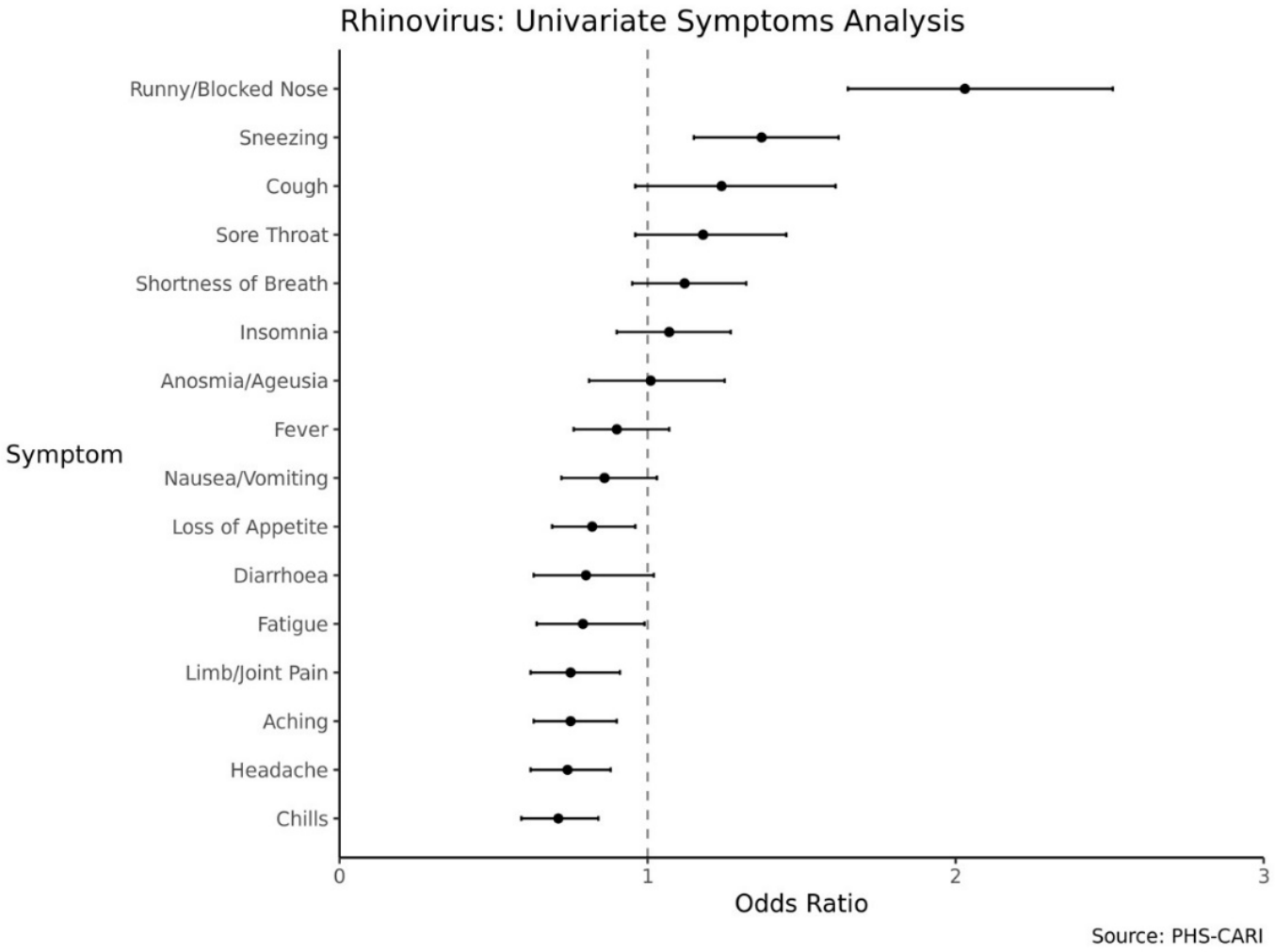


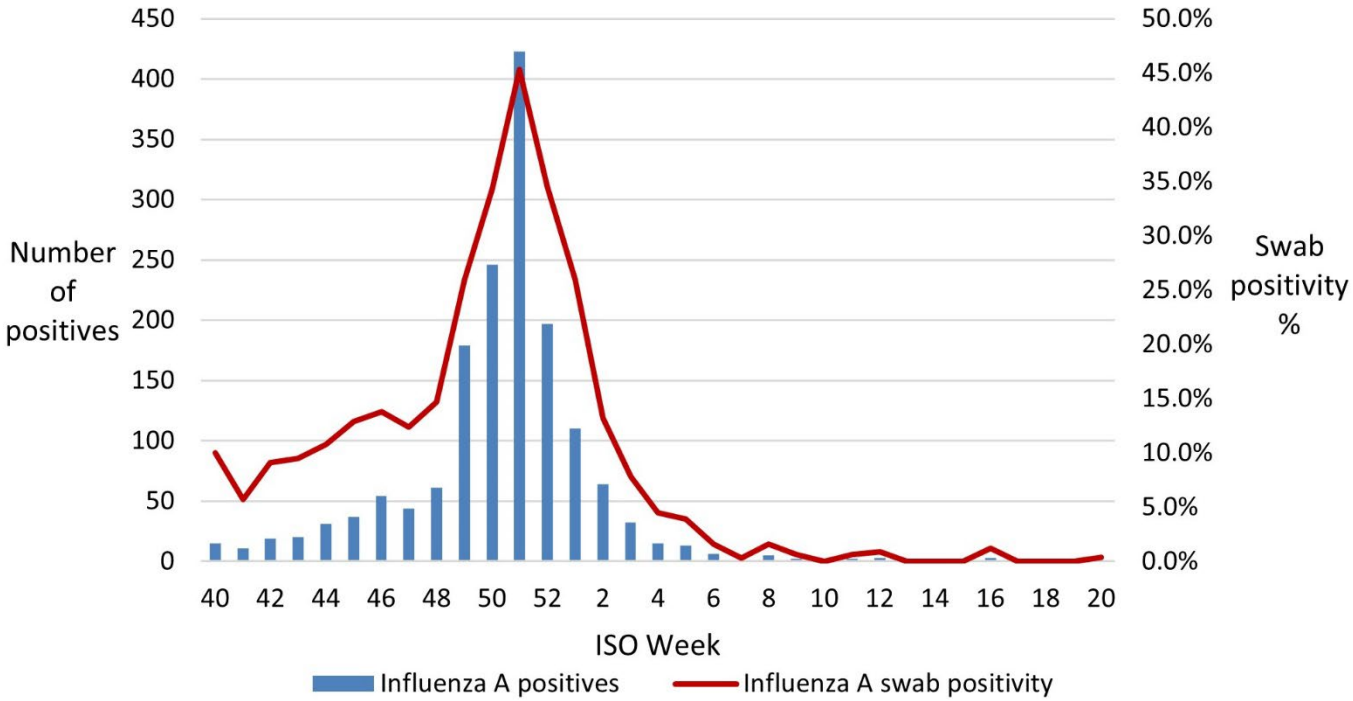
Figure 7b: Odds ratios (with 95% CI) for associations between symptoms and rhinovirus positivity



Influenza A

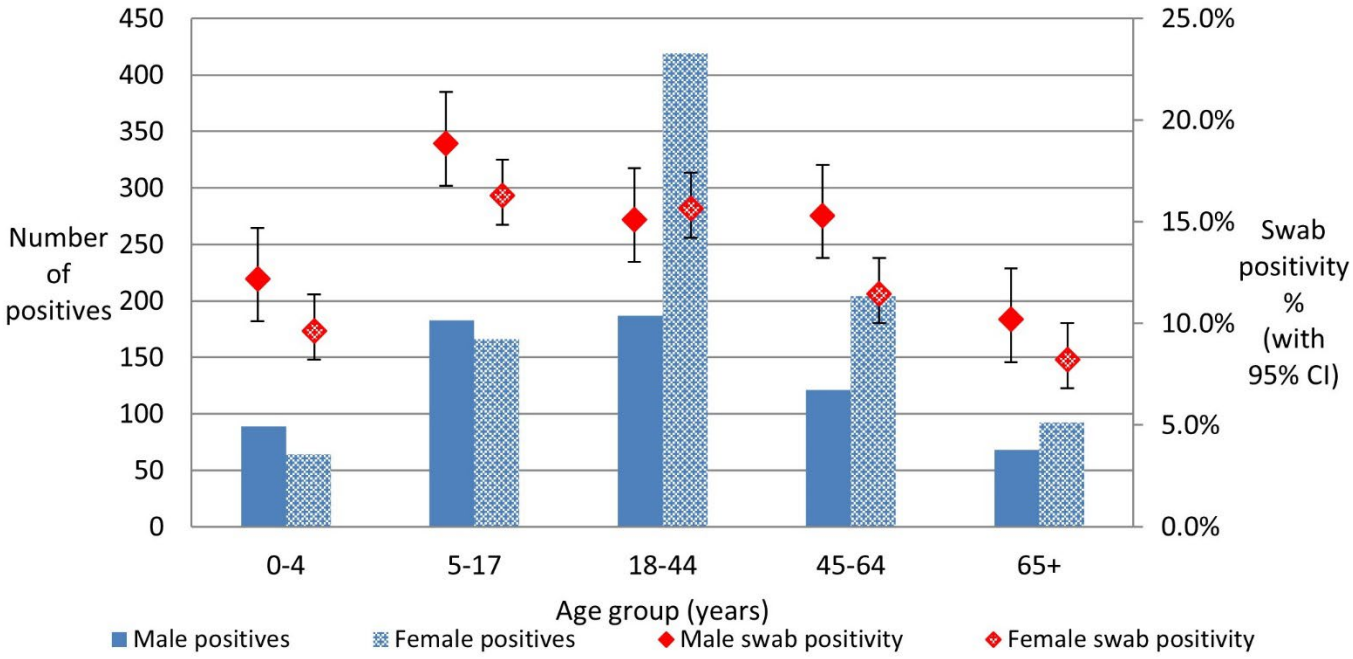
Influenza A was the second-highest circulating pathogen in the community in the 2022/2023 season, with an overall swab positivity of 13.7% (95% CI: 13.1 to 14.3). This was in contrast to the **2021/2022 season** when there were relatively few cases of influenza A and an overall swab positivity of 2.7%. There was a sharp increase in the number of cases between weeks 49 and 51, with swab positivity peaking at 45.3% in week 51 (Figure 8). This pattern was observed across Europe[6] and was also reflected in the highest **hospital admission rates for influenza in Scotland** since the 2016/2017 season. Very few cases of influenza A were observed after week 4.

Figure 8: Number of samples positive for influenza A and swab positivity over time (week 40, 2022 to week 20, 2023)



For all swabs submitted to week 20, swab positivity for influenza A was higher in males in all age groups, apart from the 18–44 age group. Swab positivity was highest in the 5–17 age group: 18.9% (95% CI: 16.5 to 21.4) in males and 16.3% (95% CI: 14.2 to 18.7) in females. Lowest swab positivity was recorded for females in the 65+ age group at 8.2% (95% CI: 6.8 to 10.0).

Figure 9: Number of positive samples and swab positivity for influenza A, by age and sex



Fever, chills and cough were the most common symptoms in people with influenza A (Figure 10a). All symptoms, apart from diarrhoea and sore throat, were more likely to be reported by patients positive for influenza A compared with all other patients (Figure 10b).

Figure 10a: Number of positive influenza A cases reporting symptoms

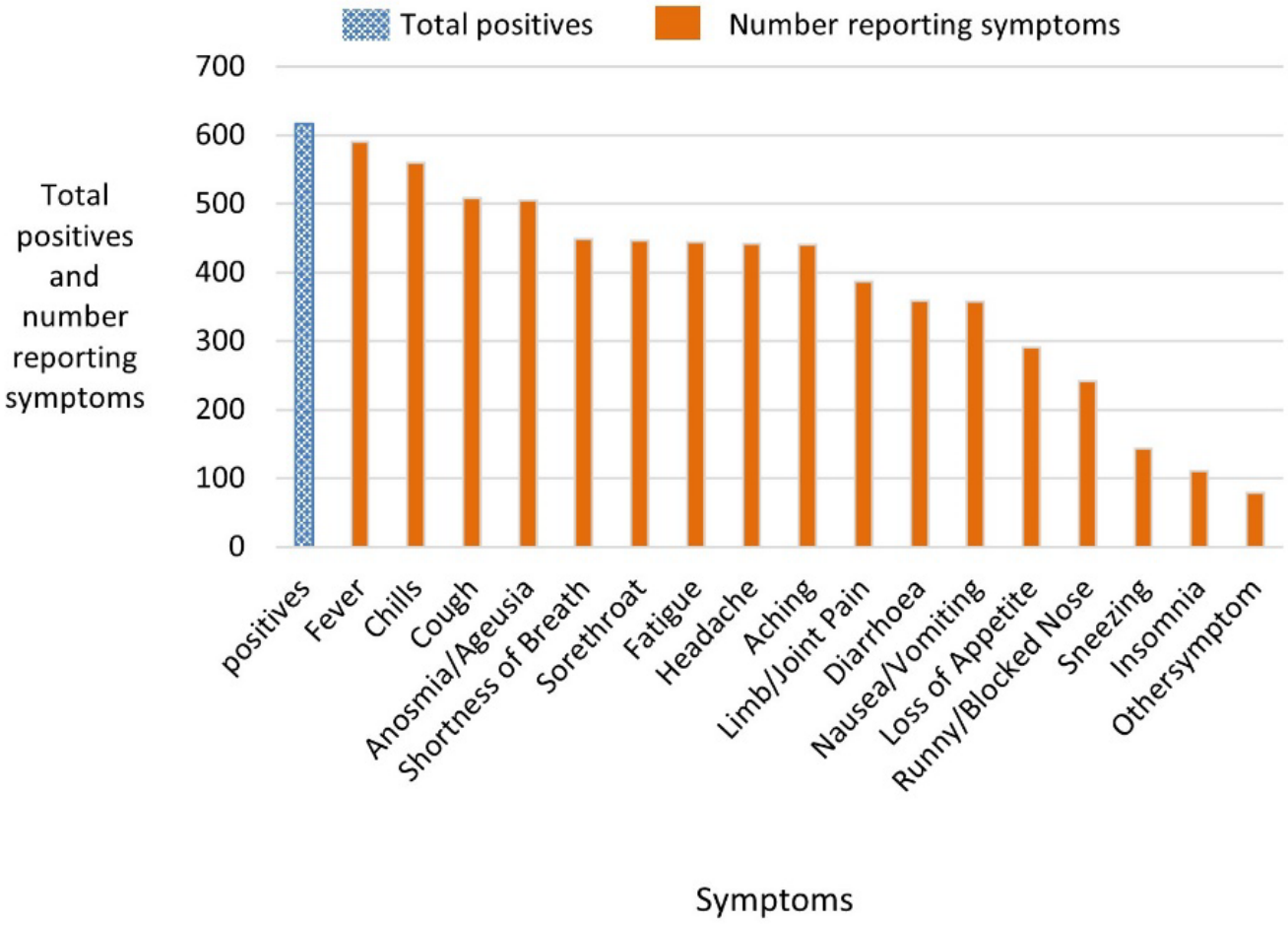
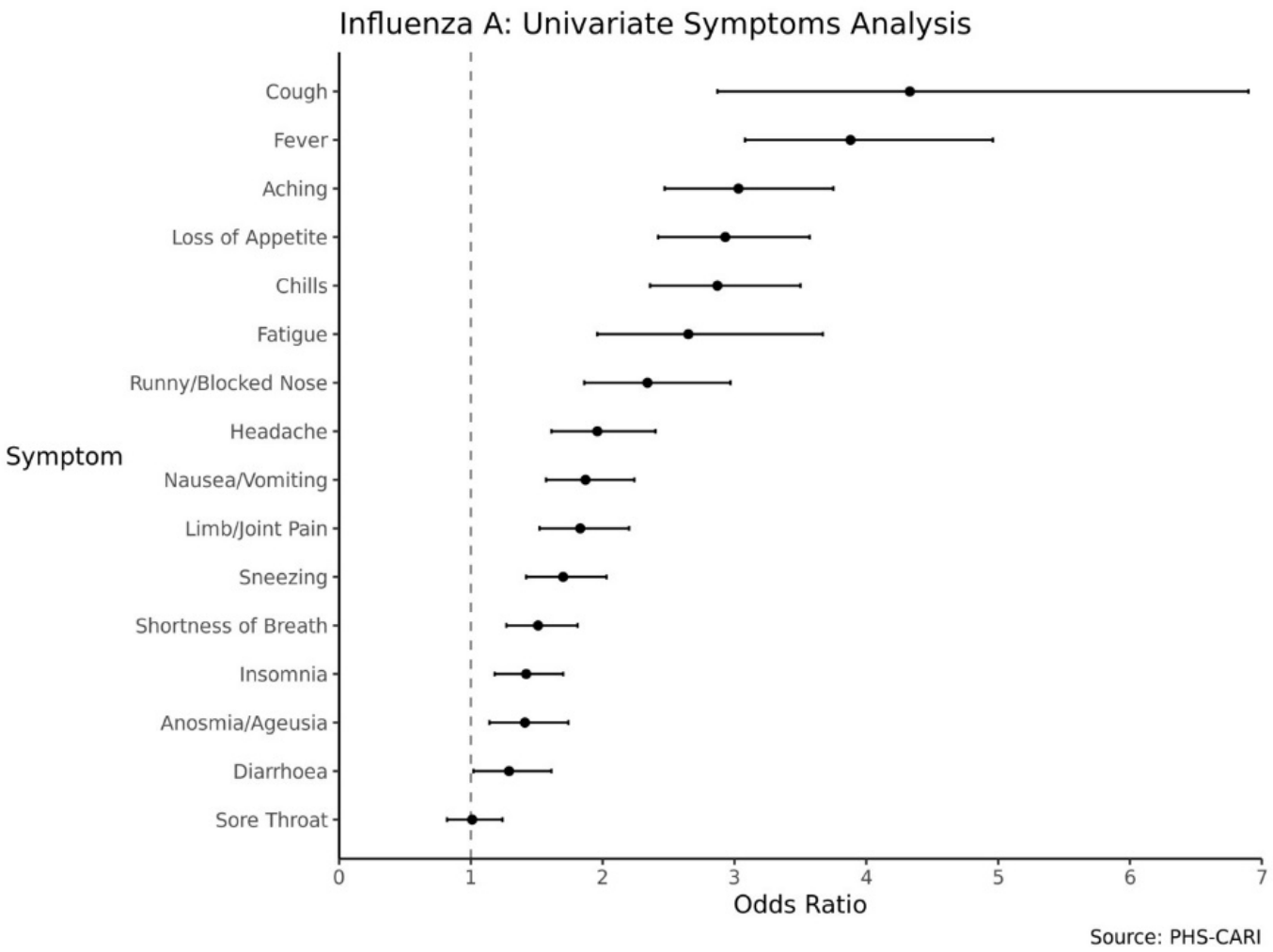


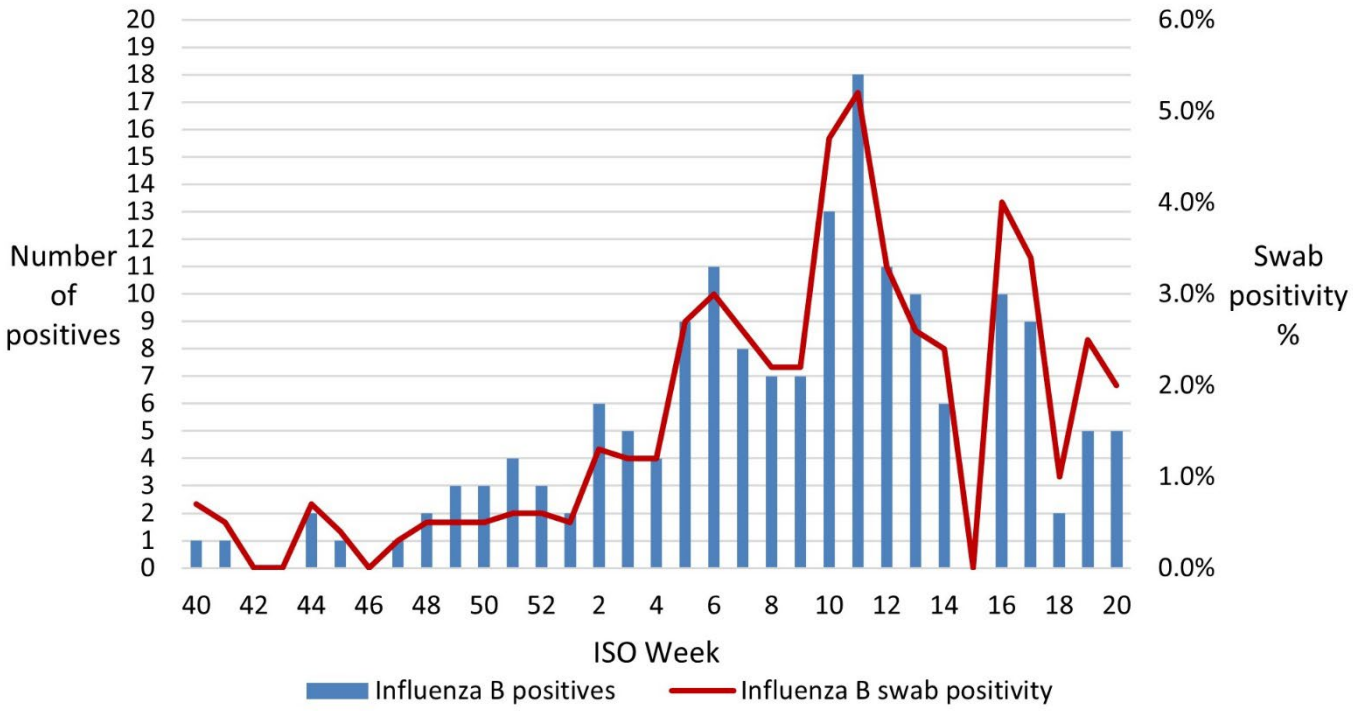
Figure 10b: Odds ratios (with 95% CI) for associations between symptoms and influenza A positivity



Influenza B

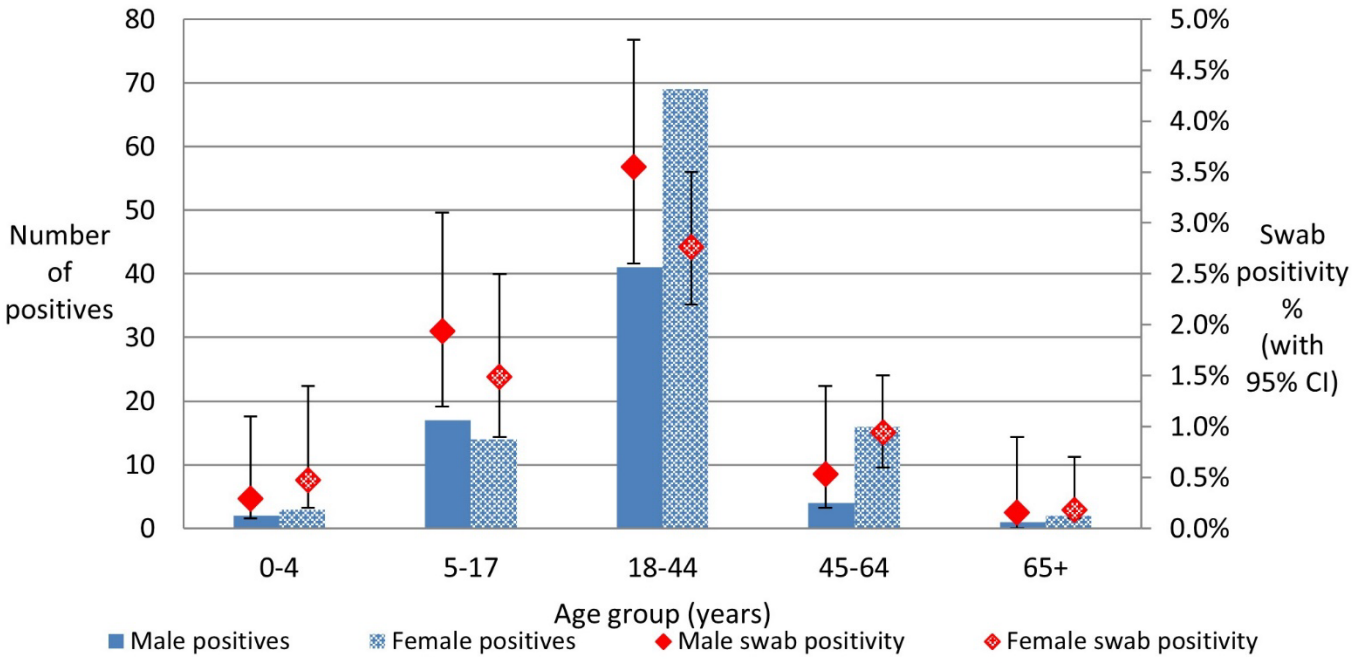
Overall swab positivity for influenza B was 1.5% (95% CI: 1.3 to 1.8). Although influenza B was low overall, it was higher than observed in the **2021/2022 season**, and began to increase after week 2, reaching a peak of 5.2% in week 11 (Figure 11). Influenza B was more commonly detected than influenza A from this time point, although overall numbers remained low. Higher circulation of type B influenza was also recorded across Europe from week 2.[7]

Figure 11: Number of samples positive for influenza B and swab positivity over time (week 40, 2022 to week 20, 2023)



For all swabs submitted to week 20, swab positivity for influenza B was highest in the 18–44 age group, followed by the 5–17 age group, and was higher in males in these age groups (Figure 12). Low swab positivity was recorded in the 0–4 and 65+ age groups for both males and females.

Figure 12: Number of positive samples and swab positivity for influenza B, by age and sex



Fever, chills and cough were the most common symptoms in people with influenza B (Figure 13a). In general, the symptoms reported for influenza B were very similar to those of influenza A. Fever and chills were more likely to be reported by patients positive for influenza B compared with all other patients (Figure 13b).

Figure 13a: Number of positive influenza B cases reporting symptoms

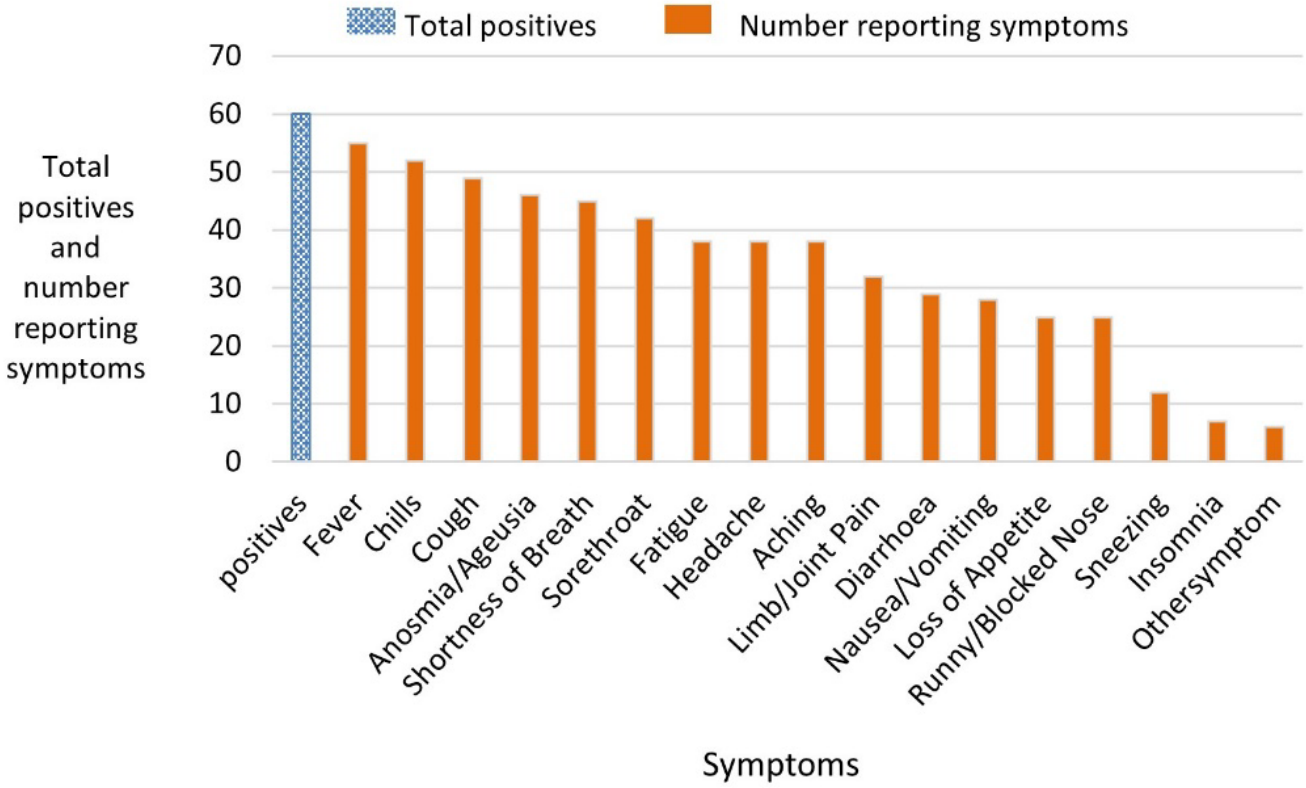
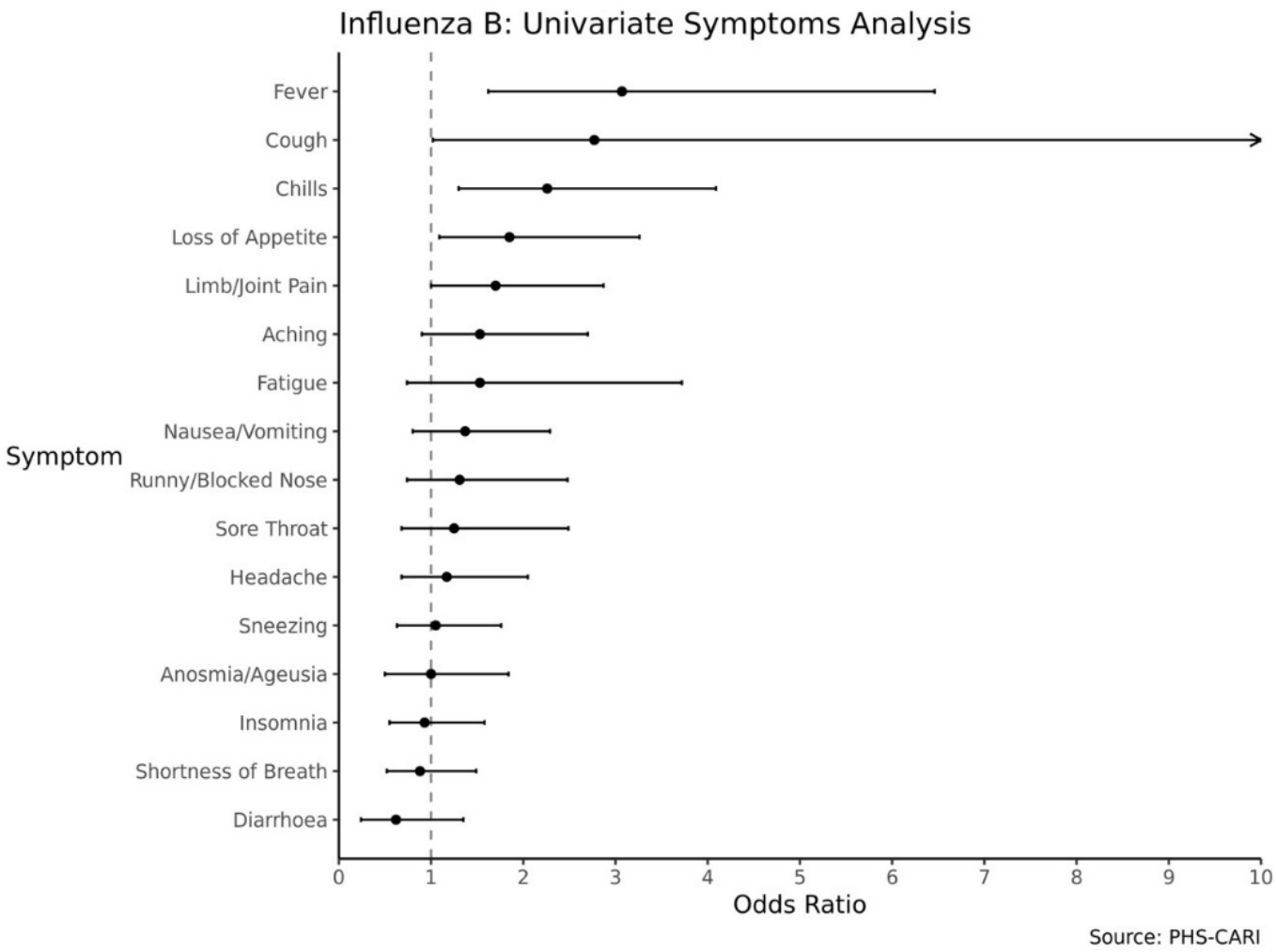


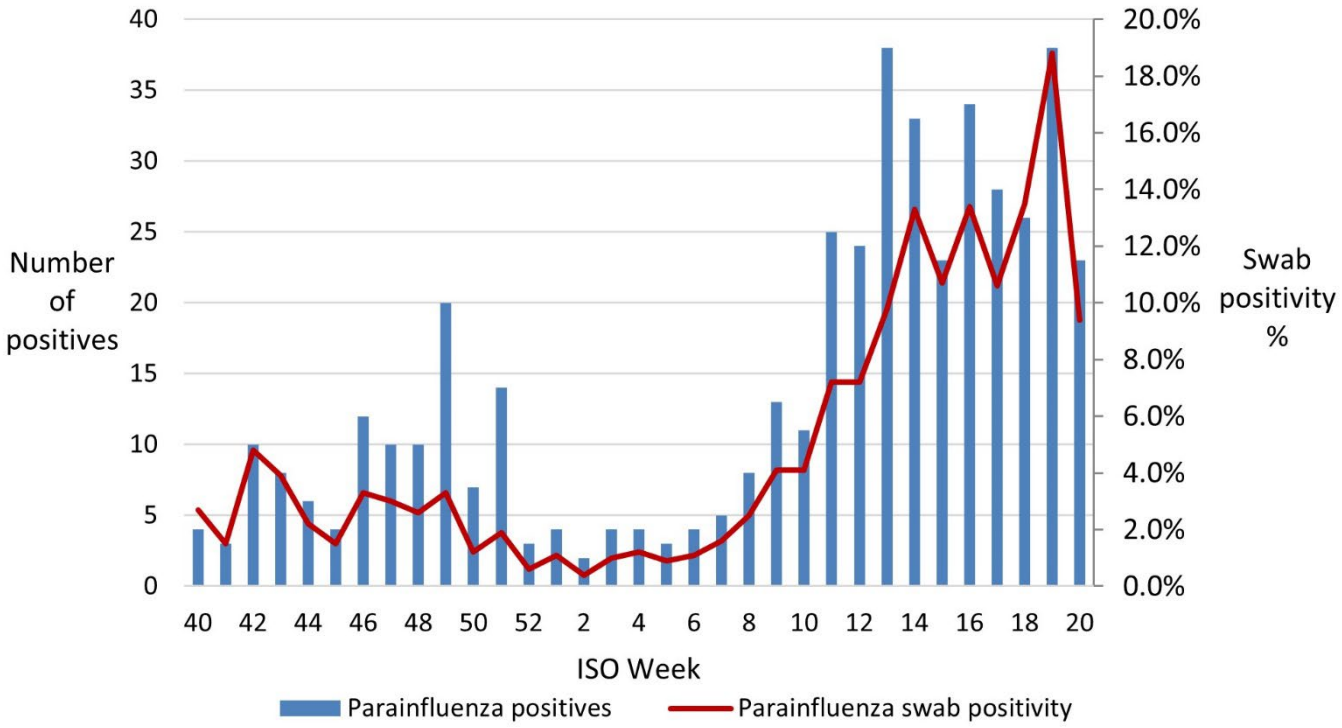
Figure 13b: Odds ratios (with 95% CI) for associations between symptoms and influenza B positivity



Parainfluenza

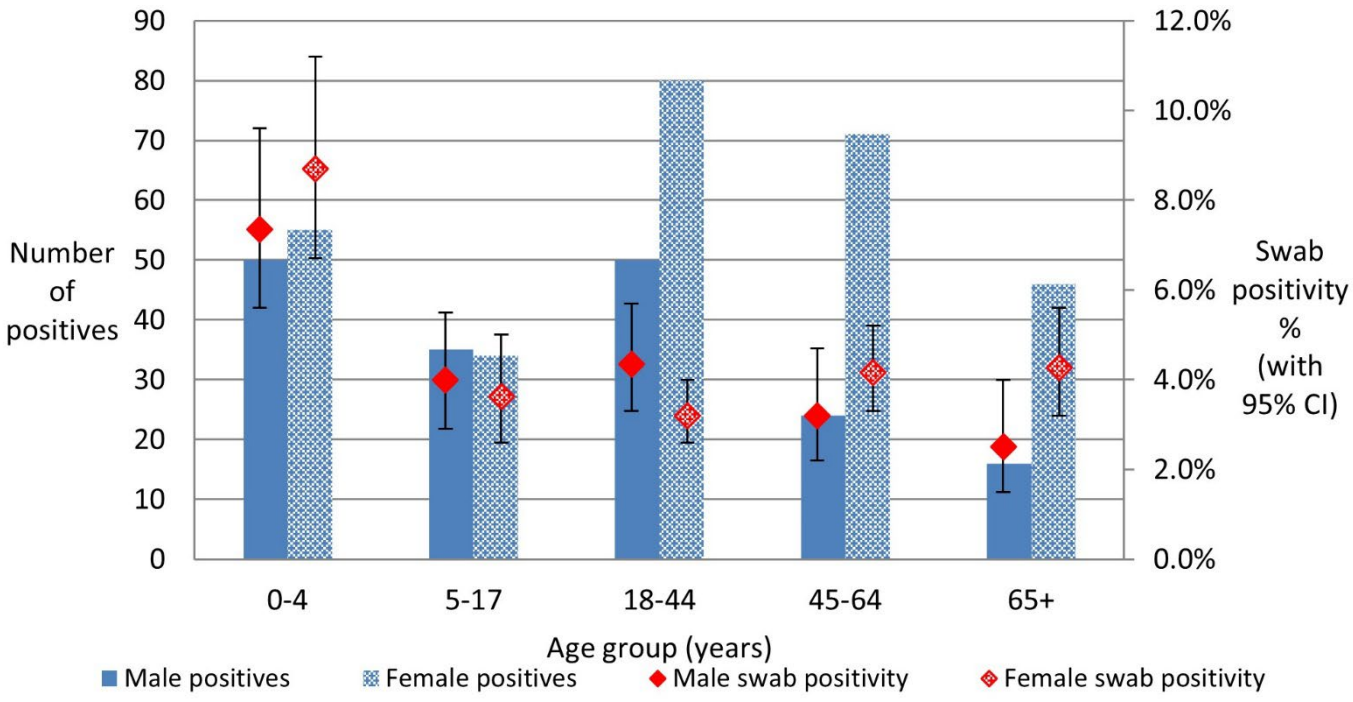
Overall swab positivity for parainfluenza was 4.2% (95% CI: 3.8 to 4.6) which is lower than **season 2021/2022** at 6.4%, when there was a high peak of parainfluenza-type 3 in autumn 2021, and higher than expected levels during the rest of the season. Prior to the COVID-19 pandemic, parainfluenza showed predictable patterns of seasonality, and annual outbreaks of parainfluenza-type 3 usually occurred in the spring.[7] In the 2022/2023 season, swab positivity stayed relatively low for the first half of the season but started to increase around early springtime in week 09 and was at its highest in week 19 at 18.8% (Figure 14). This was mainly attributable to parainfluenza-type 3, but there was some parainfluenza-type 4 activity, which usually occurs in the second half of the year.

Figure 14: Number of samples positive for parainfluenza and swab positivity over time (week 40, 2022 to week 20, 2023)



For all swabs submitted to week 20, swab positivity was highest in the 0–4-year age group, but broadly similar across the other age groups. This is not unexpected, given that young children are known to be most vulnerable to parainfluenza infection.[7]

Figure 15: Number of positive samples and swab positivity for parainfluenza, by age and sex



Cough, sore throat and runny/blocked nose were the most common symptoms reported by patients positive for parainfluenza (Figure 16a). No symptoms were more likely to be reported by patients with parainfluenza compared to other patients, although reporting of chills, fatigue and limb/joint pain was negatively associated with testing positive for parainfluenza (Figure 16b).

Figure 16a: Number of positive parainfluenza cases reporting symptoms

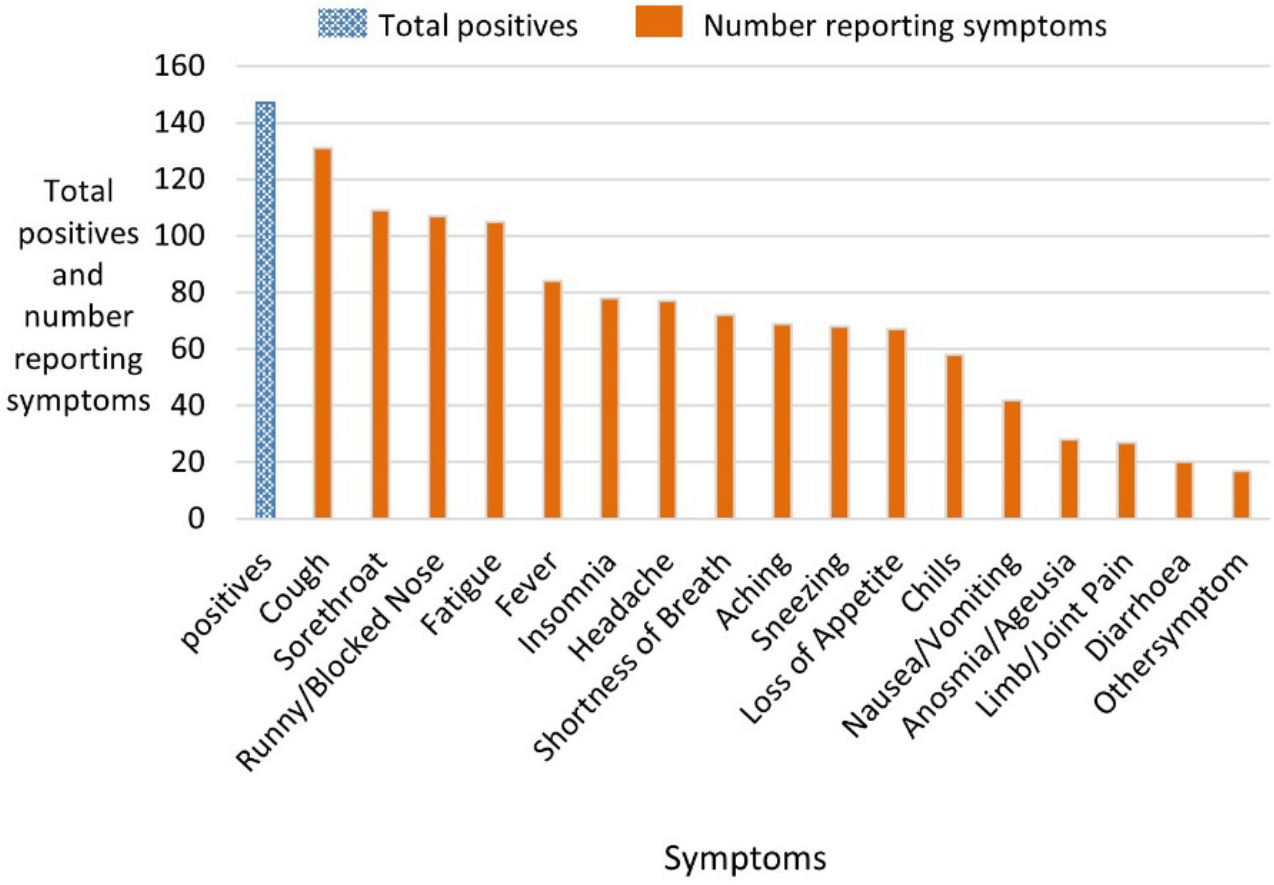
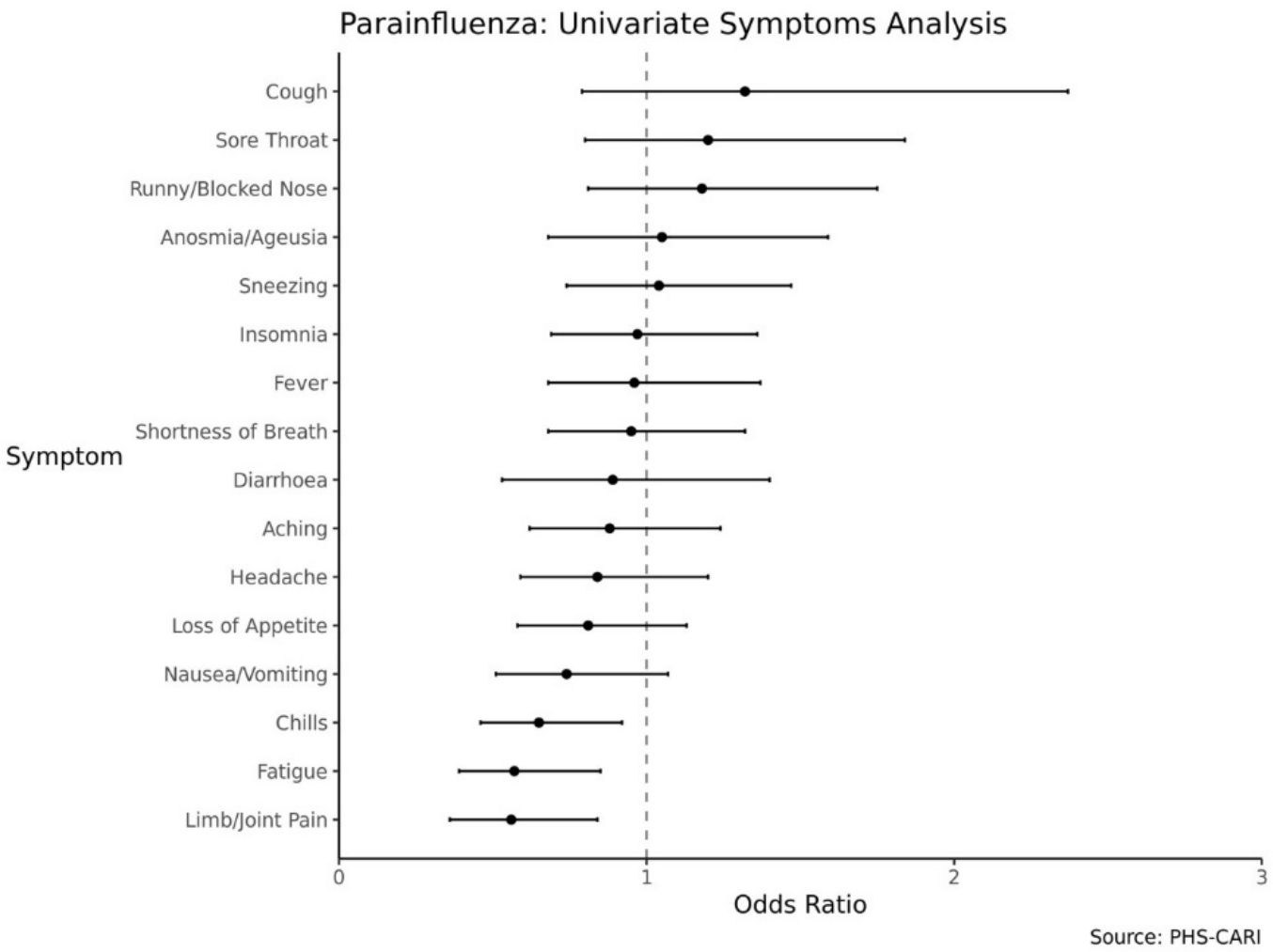


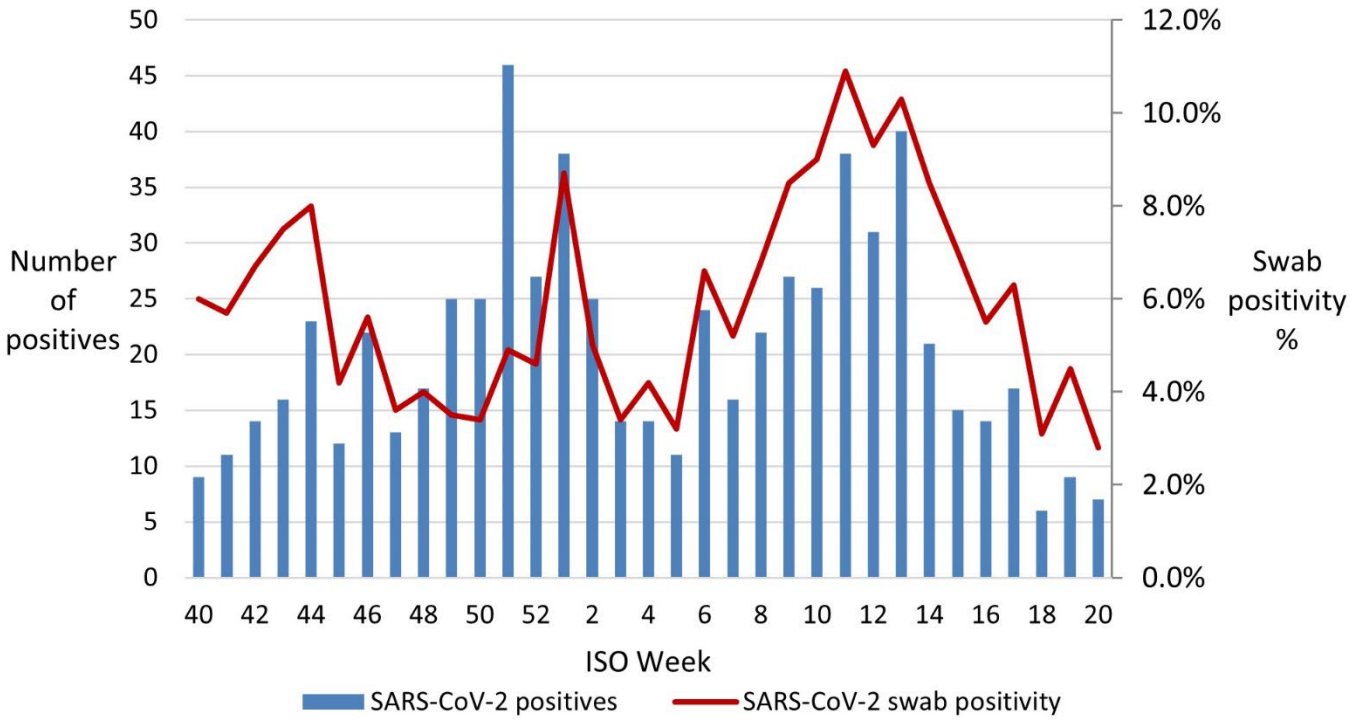
Figure 16b: Odds ratios (with 95% CI) for associations between symptoms and parainfluenza positivity



SARS-CoV-2

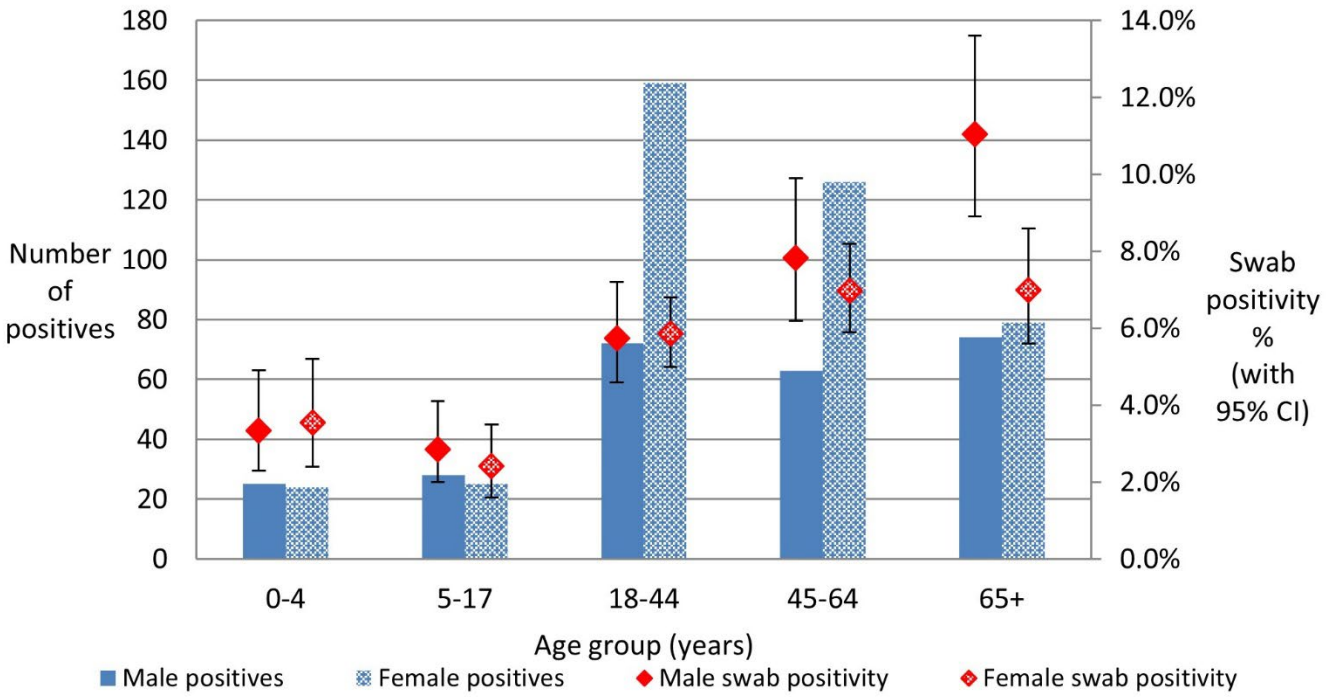
Overall swab positivity for SARS-CoV-2 was 5.7% (95% CI: 5.3 to 6.1) which was lower than the **2021/2022 season** at 10.2%. Although swab positivity fluctuated over time, there were several peaks seen over the season, with the highest swab positivity recorded in week 11 at 10.9%. There was increased activity just after the festive season, and then again around springtime, but overall the trend was for decreasing or stable activity, as was also observed across Europe at this time.[8]

Figure 17: Number of samples positive for SARS-CoV-2 and swab positivity over time (week 40, 2022 to week 20, 2023)



For all swabs submitted to week 20, swab positivity for SARS-CoV-2 was higher for adults. Children with SARS-CoV-2 often have comparatively mild symptoms or are asymptomatic,[9] so children with symptoms that fit the CARI case definition and who are then swabbed are more likely to test positive for other infections. Swab positivity for SARS-CoV-2 was generally similar between males and females except in the 65+ age group where males had significantly higher swab positivity of 11.0% (95% CI: 8.9 to 13.6).

Figure 18: Number of positive samples and swab positivity for SARS-CoV-2, by age and sex



Cough was the most commonly reported symptom of SARS-CoV-2, followed by fatigue, runny/blocked nose, sore throat and fever (Figure 19a), with the symptoms presentation having evolved from the early days of the pandemic to less intense acute infection.[10] Loss of sense of smell and taste is no longer a common symptom and, in contrast to the **2021/2022 season**, was no more likely to be reported by patients positive for SARS-CoV-2 compared to other patients (Figure 19b).

Figure 19a: Number of positive SARS-CoV-2 cases reporting symptoms

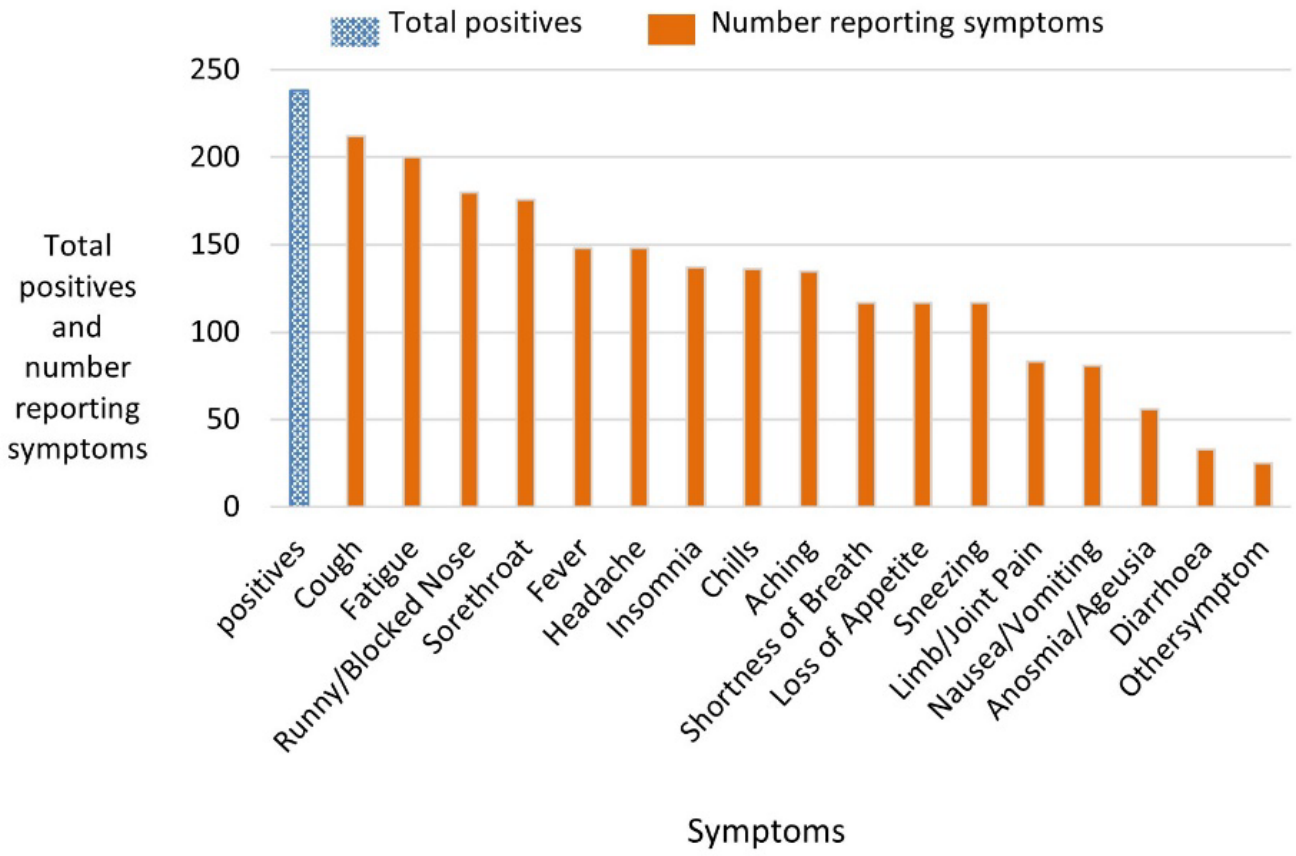
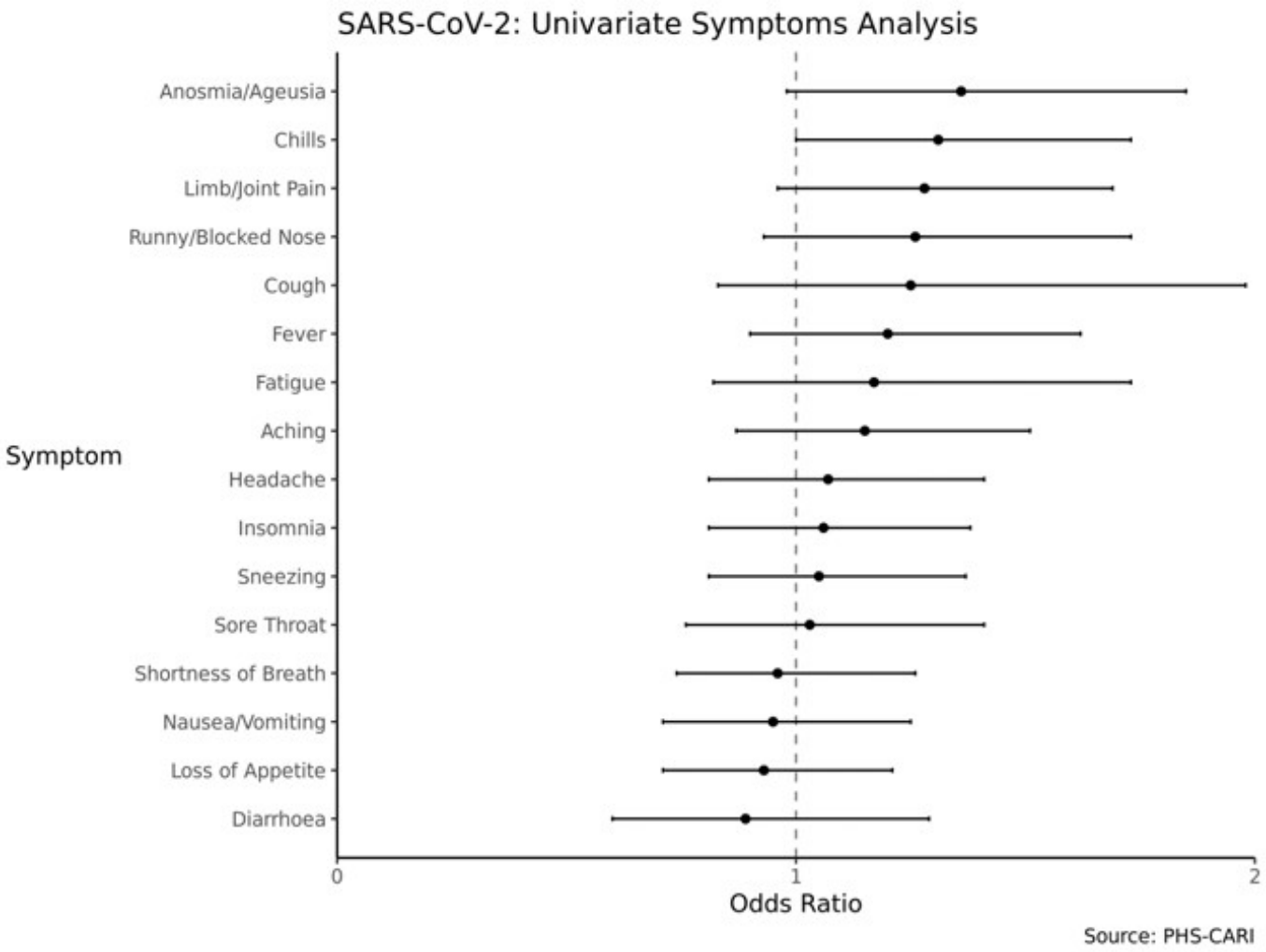


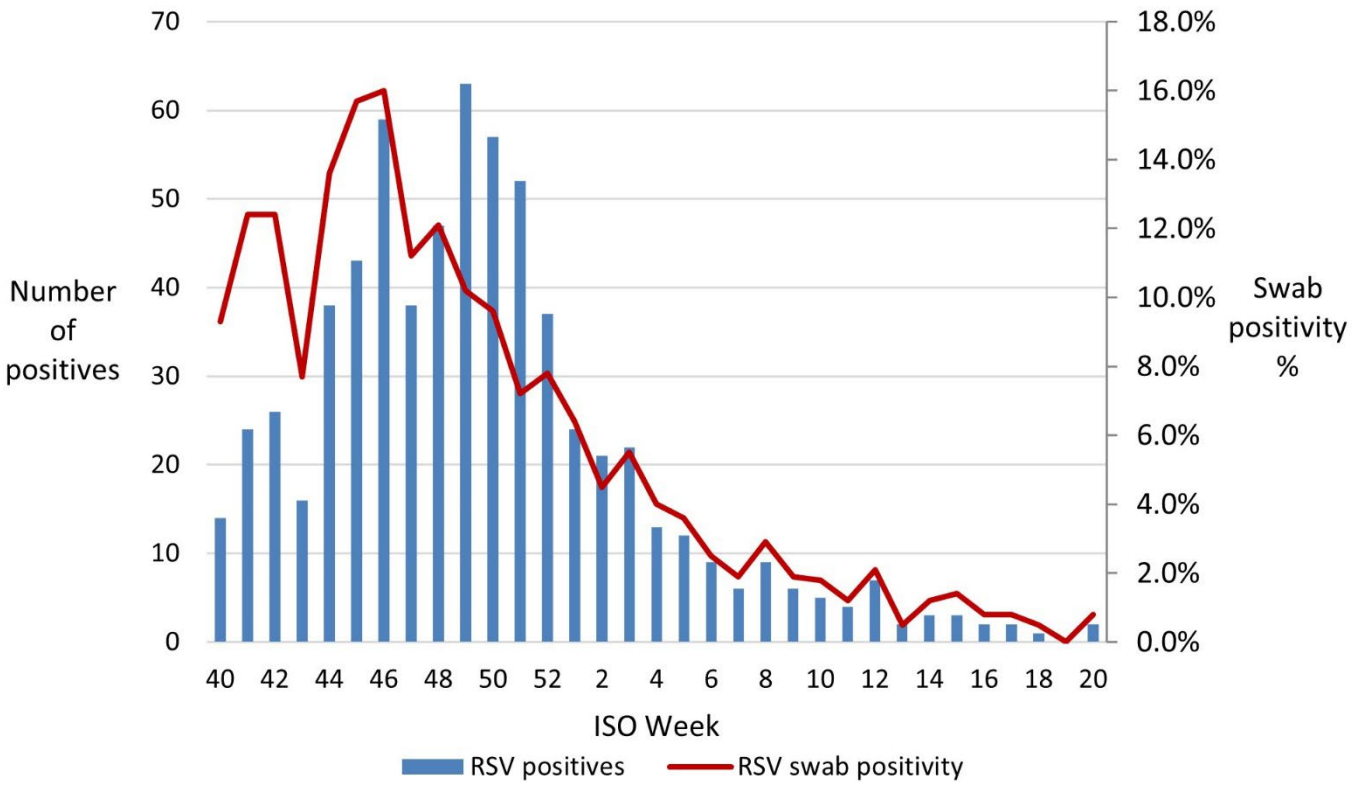
Figure 19b: Odds ratios (with 95% CI) for associations between symptoms and SARS-CoV-2 positivity



Respiratory syncytial virus (RSV)

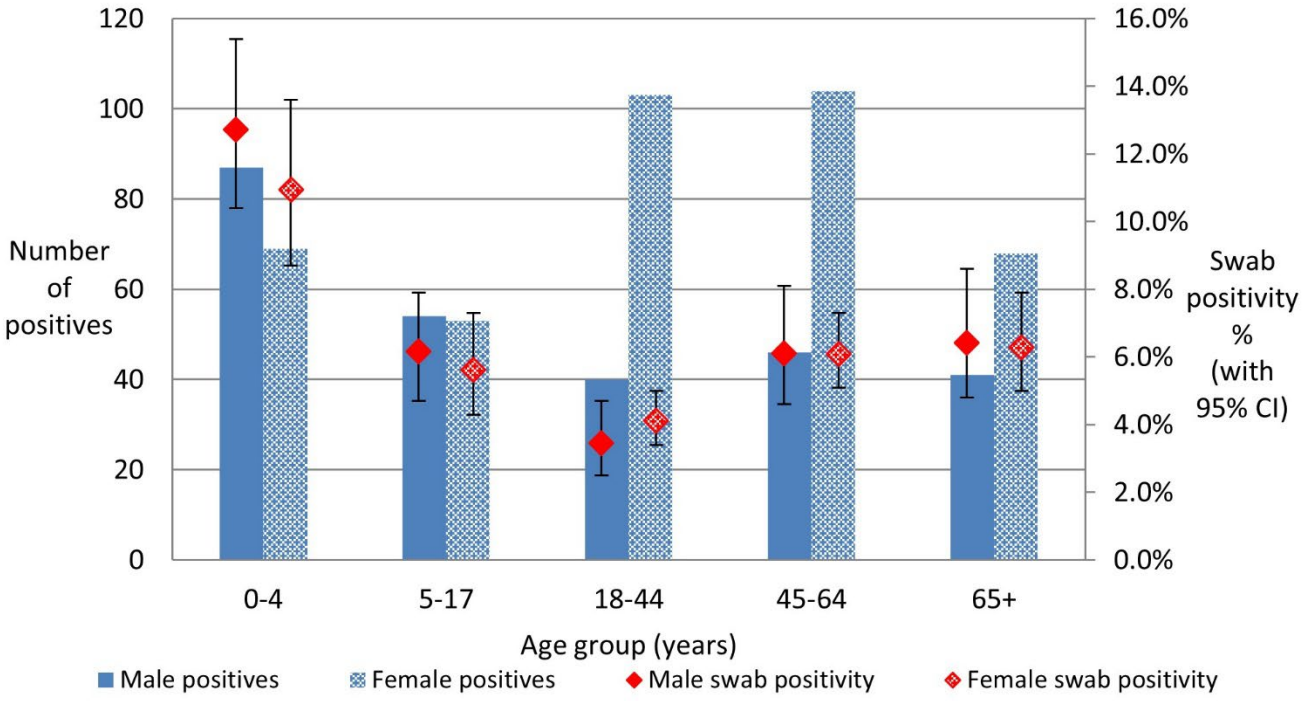
Overall swab positivity for RSV was 6.1% (95% CI: 5.6 to 6.5), which was higher than observed in the **2021/2022 season** at 4.5%. Swab positivity was high at the start of the season in week 40, peaked in week 46 at 16.0% and then declined steadily. Although the higher number of cases during autumn/winter months are in line with seasonal expectations, RSV activity, accompanied by high hospital admissions, was higher than in pre-pandemic seasons and started earlier than expected. This coincided with the pattern seen across Europe at that time, with increased reporting of paediatric hospitalisations and growing pressure on hospitals due to RSV infections.[11]

Figure 20: Number of samples positive for RSV and swab positivity over time (week 40, 2022 to week 20, 2023)



RSV causes a mild respiratory infection for most people, but young children can develop more severe disease.[12] Therefore, as would be expected, swab positivity for RSV was significantly higher in children aged 0–4 with overall swab positivity of 12.7% (95% CI: 10.4 to 15.4) in males and 11.0% (95% CI: 8.7 to 13.6) in females. Swab positivity was lower in all other age groups. There were no marked differences by gender.

Figure 21: Number of positive samples and swab positivity for RSV, by age and sex



Cough, runny/blocked nose and fatigue were the most common symptoms reported by RSV patients (Figure 22a). Cough, runny/blocked nose and sneezing were more likely to be reported by patients positive for RSV compared with all other patients. Reporting of aching was negatively associated with RSV (Figure 22b).

Figure 22a: Number of positive RSV cases reporting symptoms

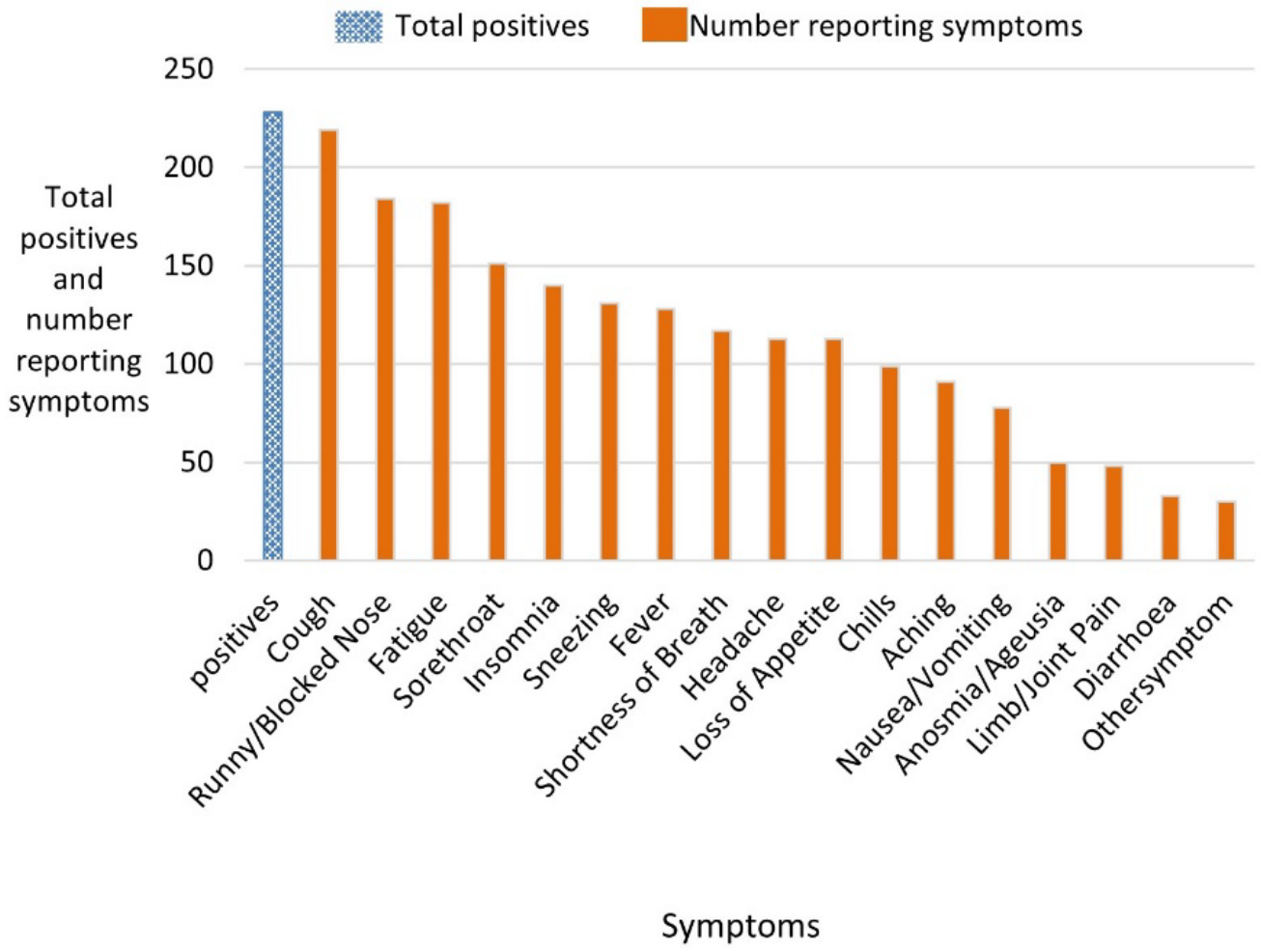
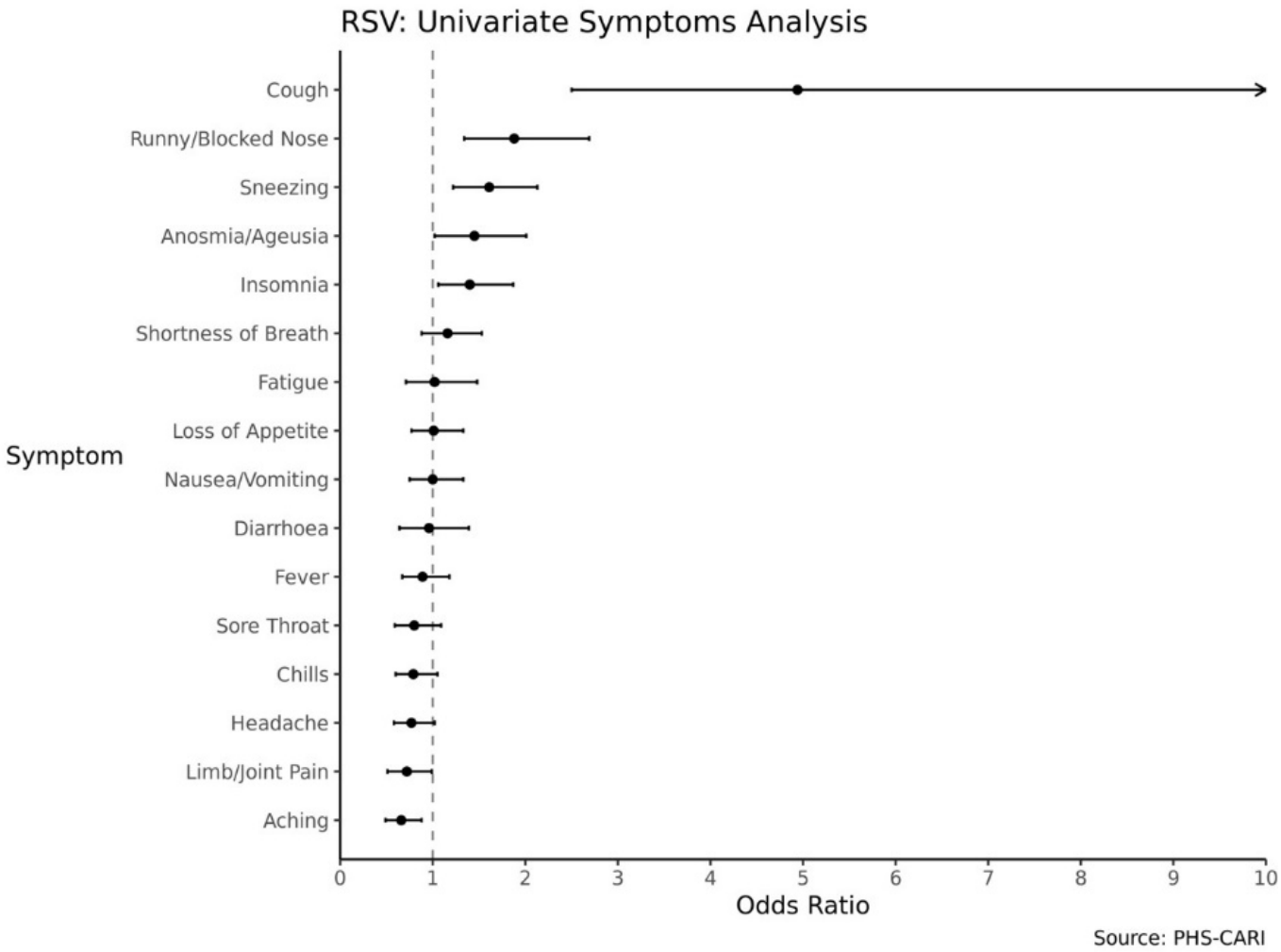


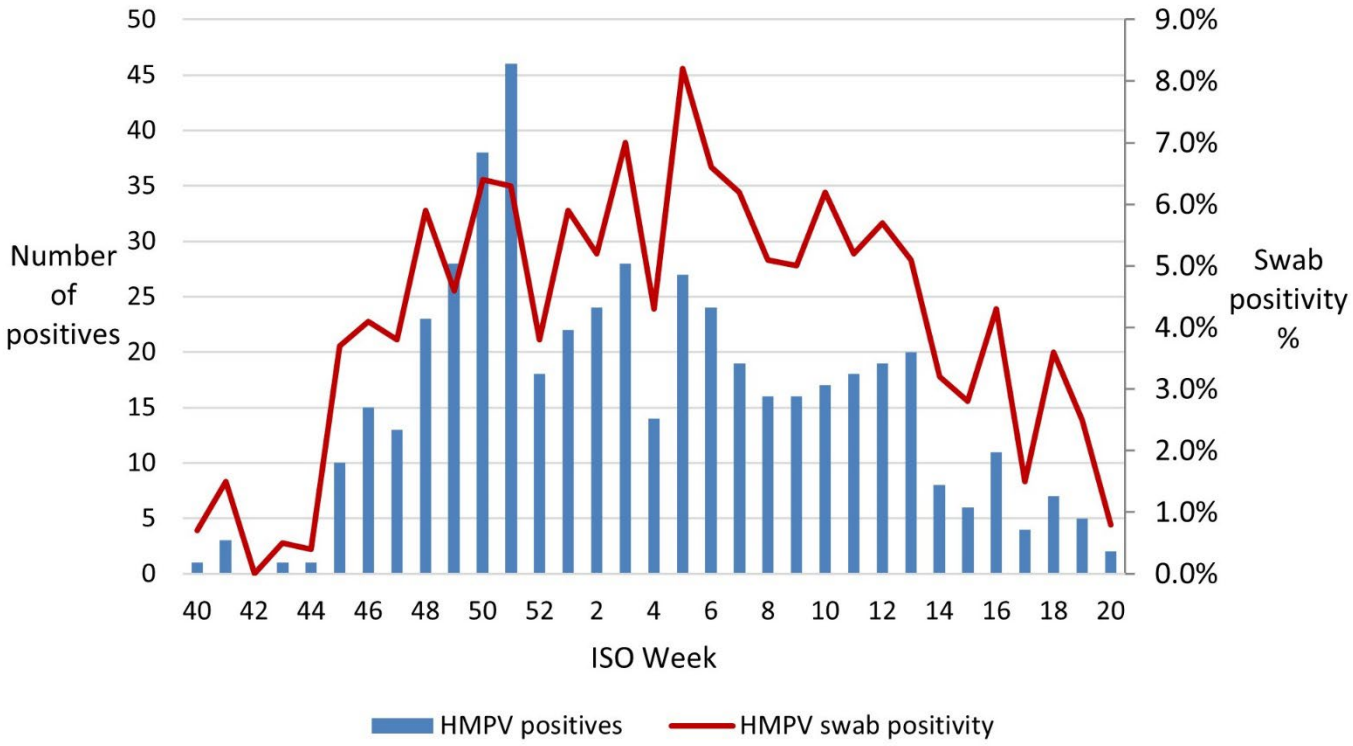
Figure 22b: Odds ratios (with 95% CI) for associations between symptoms and RSV positivity



Human metapneumovirus (HMPV)

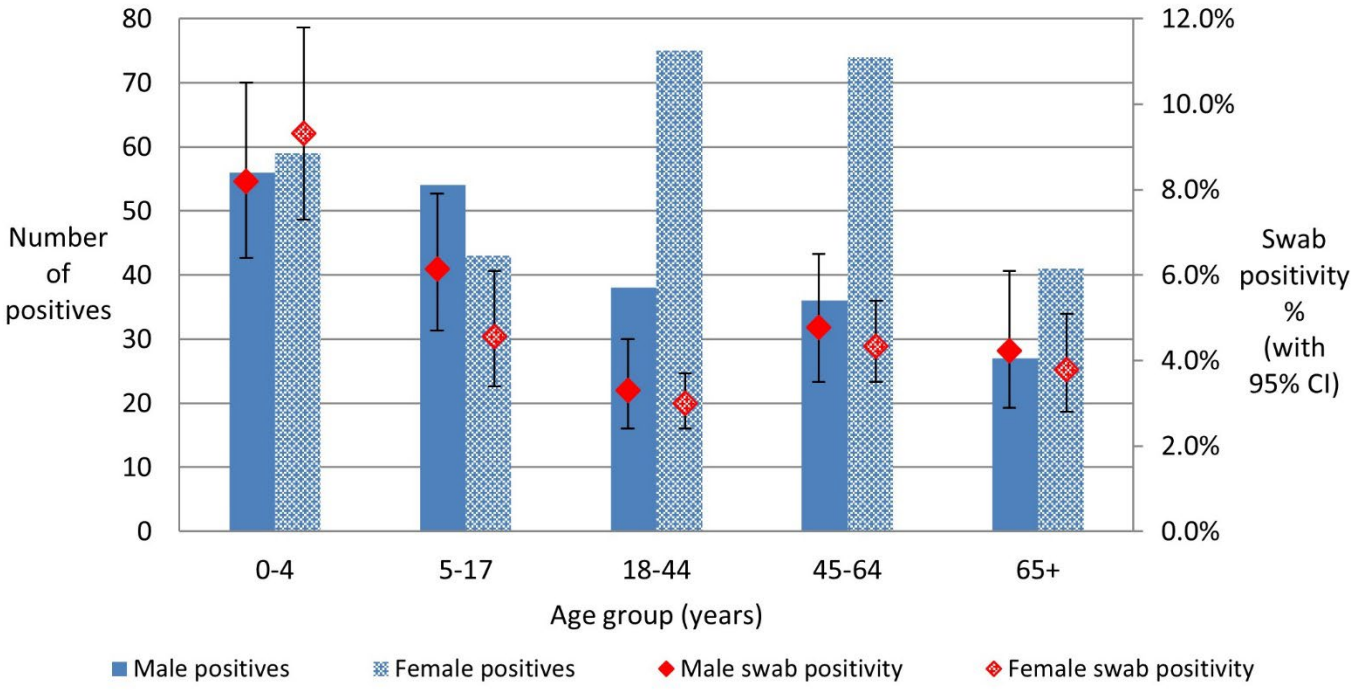
Overall swab positivity for human metapneumovirus (HMPV) was 4.6% (95% CI: 4.2 to 5.0) and was highest between week 46 and week 14 (Figure 23). In contrast, overall swab positivity was higher in the **2021/2022 season** at 7.4%, and was characterised by a high peak in swab positivity over a shorter time period.

Figure 23: Number of samples positive for HMPV and swab positivity over time (week 40, 2022 to week 20, 2023)



HMPV is recognised as being particularly common in infants and young children,[13] and overall swab positivity for HMPV was highest in the 0–4 age group: 9.3% (95% CI: 7.3 to 11.8) in females and 8.2% (95% CI: 6.4 to 10.5) in males (Figure 24). It was slightly higher for males in other age groups.

Figure 24: Number of positive samples and swab positivity for HMPV, by age and sex



Cough was the most common symptom among patients with HMPV, followed by runny/blocked nose and fatigue, with presentation very similar to RSV infection (Figure 22b).[14] Cough and runny/blocked nose, along with sneezing and shortness of breath, were more likely to be reported by patients positive for HMPV compared with all other patients (Figure 25a). Reporting of sore throat was negatively associated with HPMV positivity (Figure 25b).

Figure 25a: Number of positive HMPV cases reporting symptoms

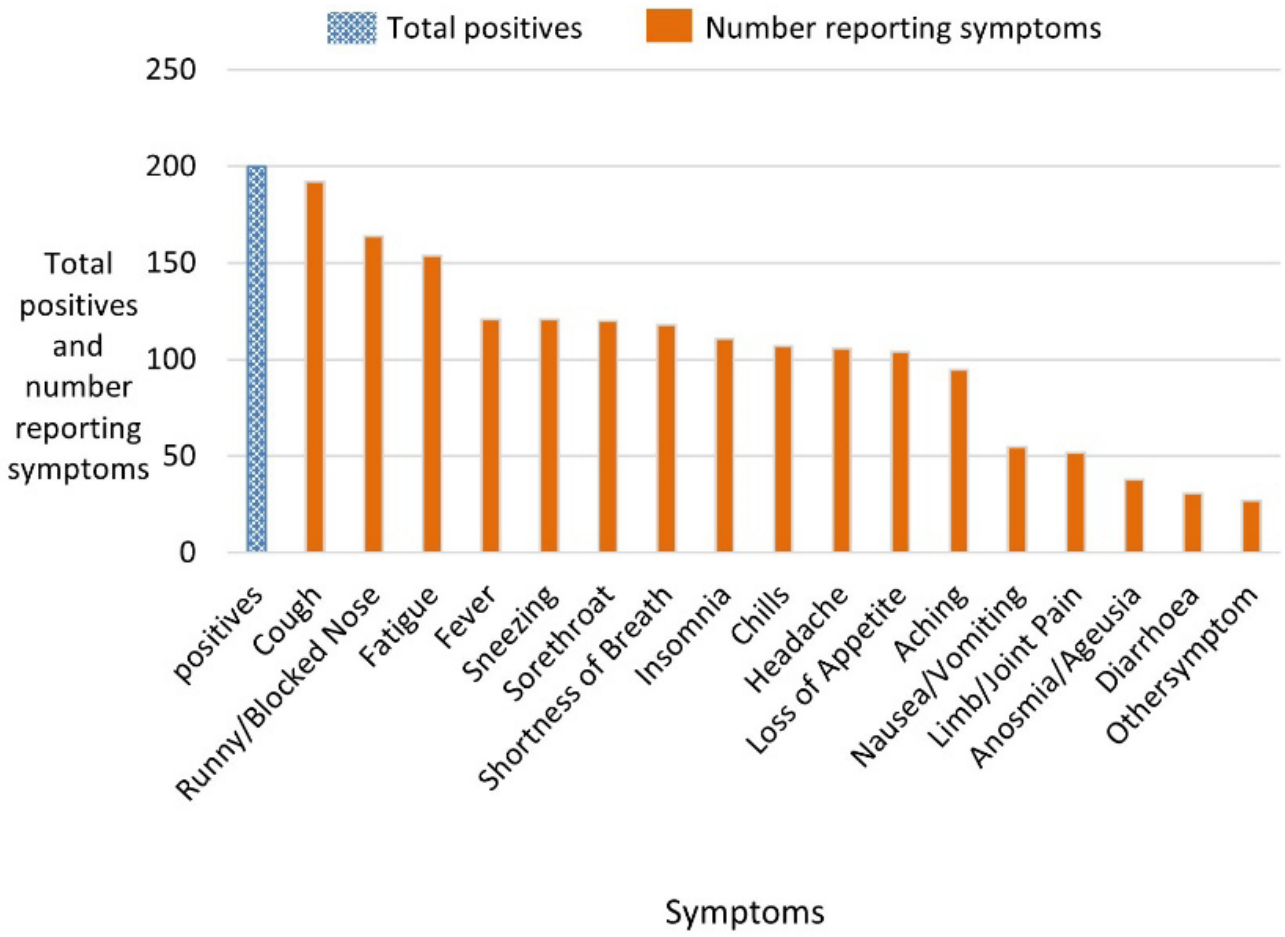
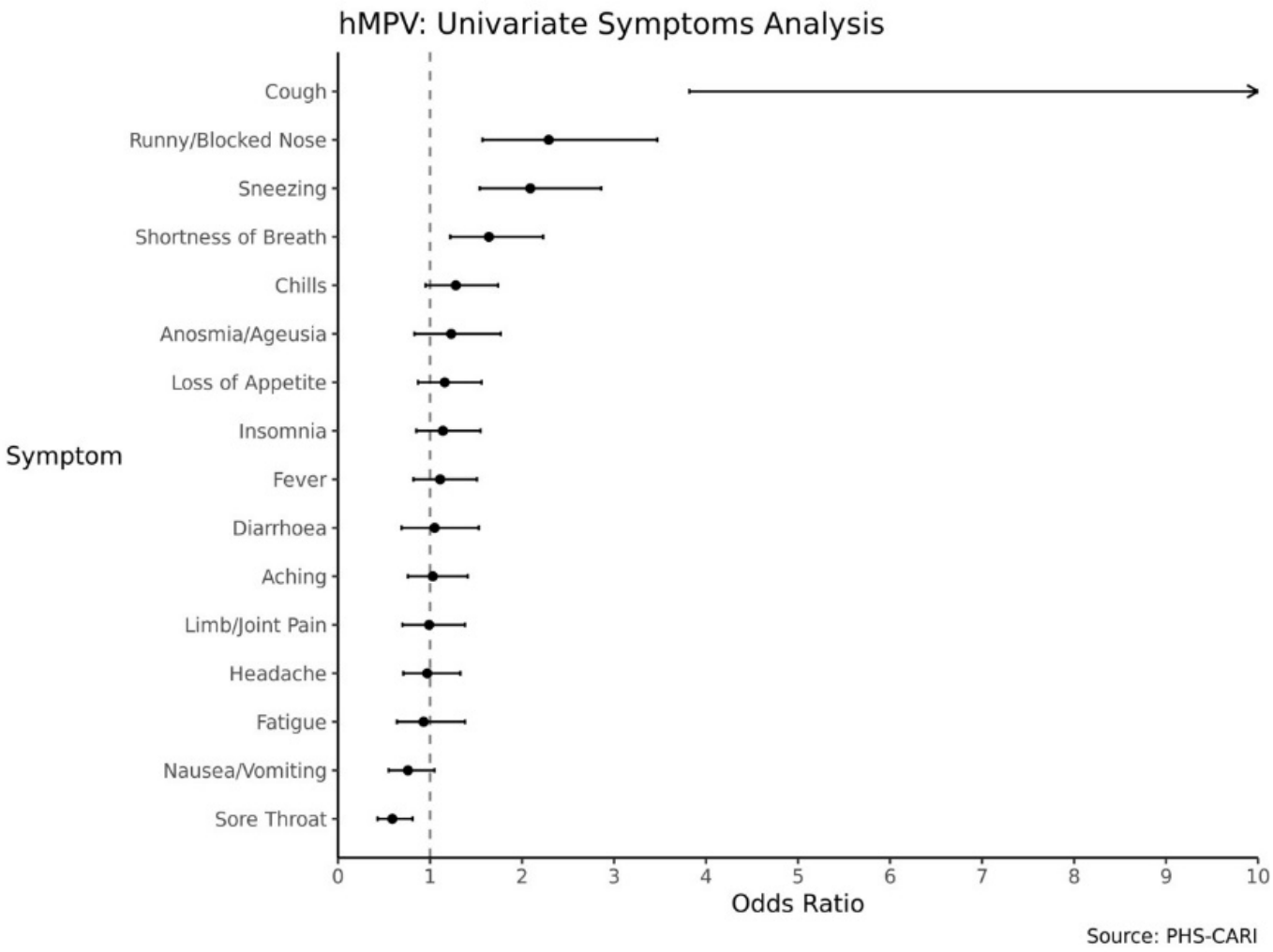


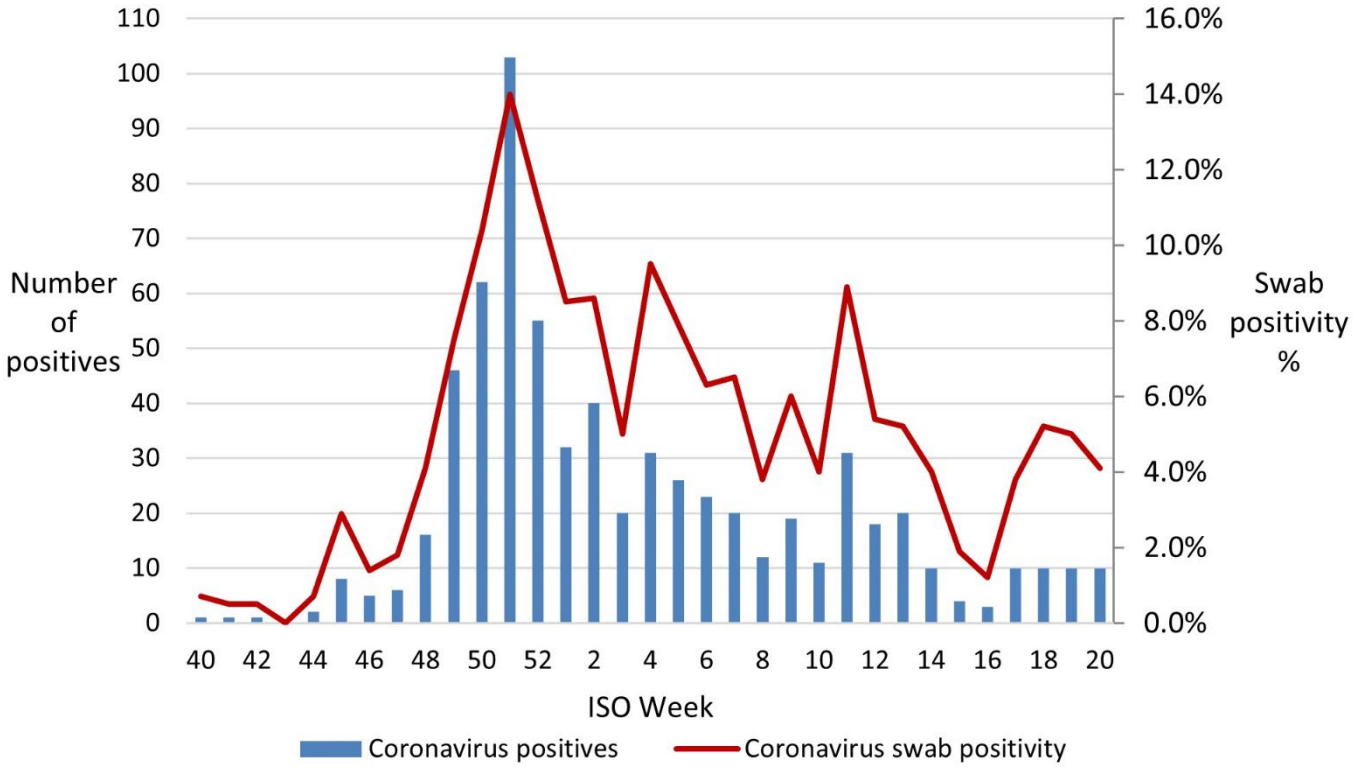
Figure 25b: Odds ratios (with 95% CI) for associations between symptoms and HMPV positivity



Seasonal coronavirus (non-SARS-CoV-2)

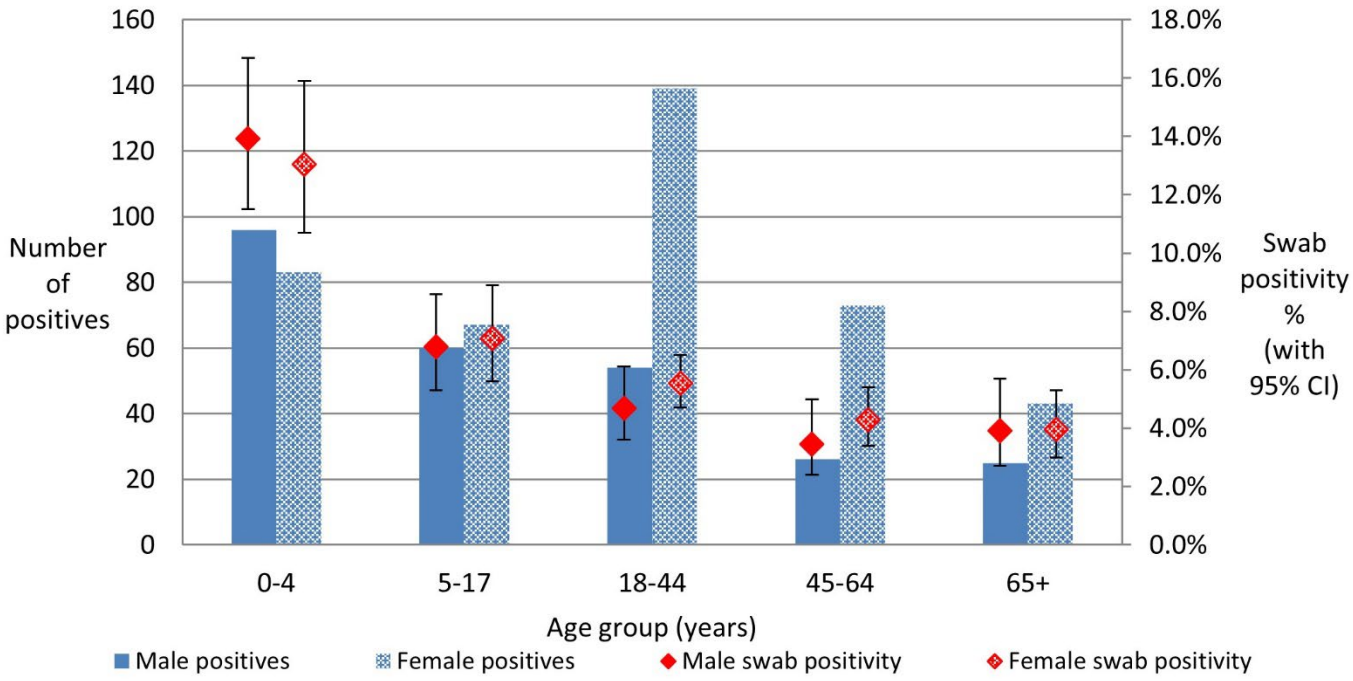
Overall swab positivity for non-SARS-CoV-2 was 6.1% (95% CI: 5.6 to 6.5) (Figure 26) which was lower than observed in the **2021/2022 season** when overall swab positivity was 7.3%. Swab positivity peaked in week 51 to 14.0%. Winter peaks in coronaviruses are frequently observed.[14]

Figure 26: Number of samples positive for seasonal coronavirus and swab positivity over time (week 40, 2022 to week 20, 2023)



For all swabs submitted to week 20, overall swab positivity for seasonal coronavirus was significantly higher in the 0–4-year age group: 13.9% (95% CI: 11.5 to 16.7) in males and 13.1% (95% CI: 10.7 to 15.9) in females (Figure 27), again aligning with known patterns of incidence.[14] There were no marked differences by gender.

Figure 27: Number of positive samples and swab positivity for seasonal coronavirus, by age and sex



Cough, runny/blocked nose and fatigue were the most common symptoms reported by patients with seasonal coronavirus (Figure 28a). Runny/blocked nose, cough and sneezing were more likely to be reported by patients positive for seasonal coronavirus compared with all other patients. Reporting of headache was negatively associated with seasonal coronavirus positivity (Figure 28b).

Figure 28a: Number of positive seasonal coronavirus cases reporting symptoms

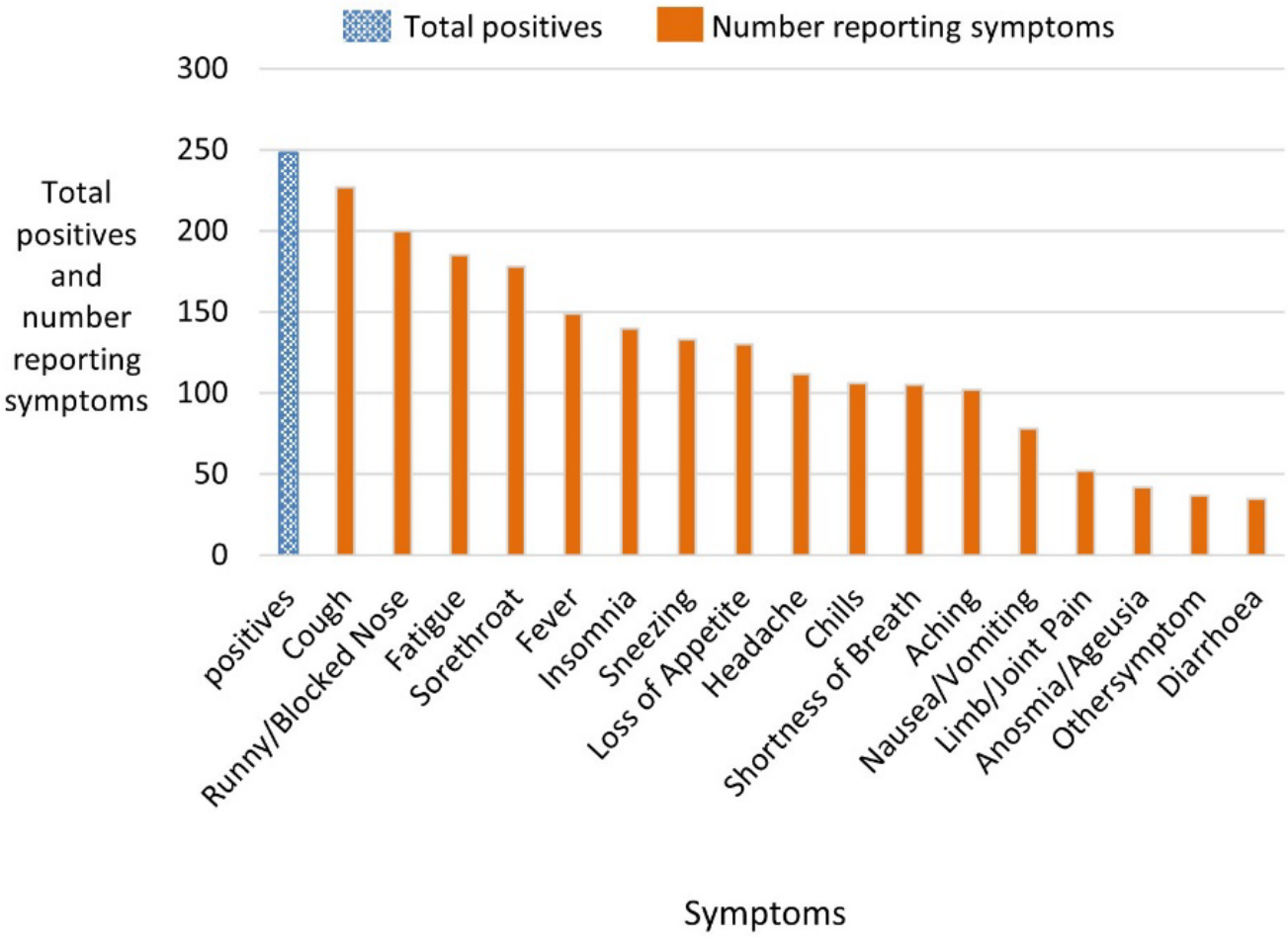
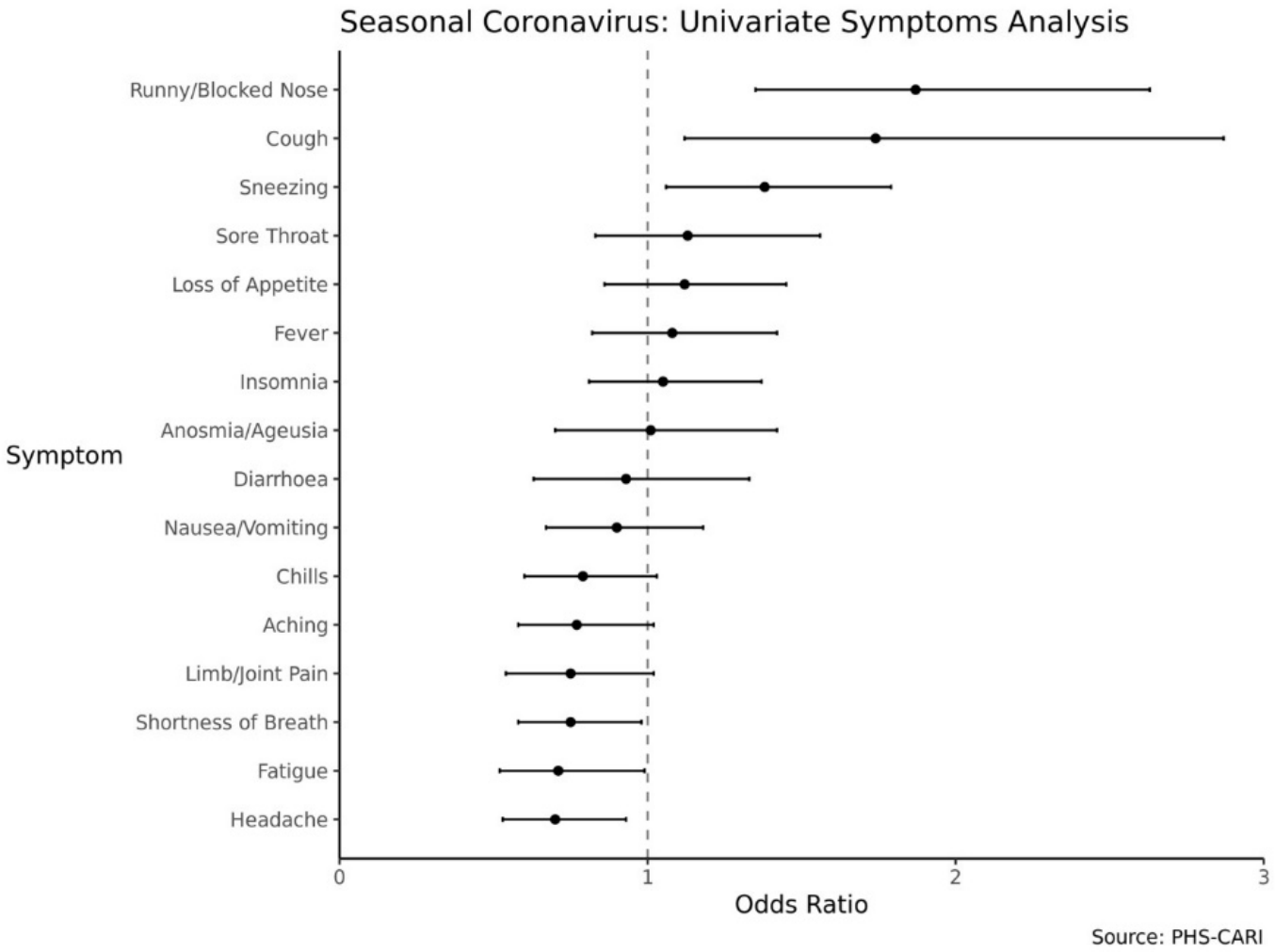


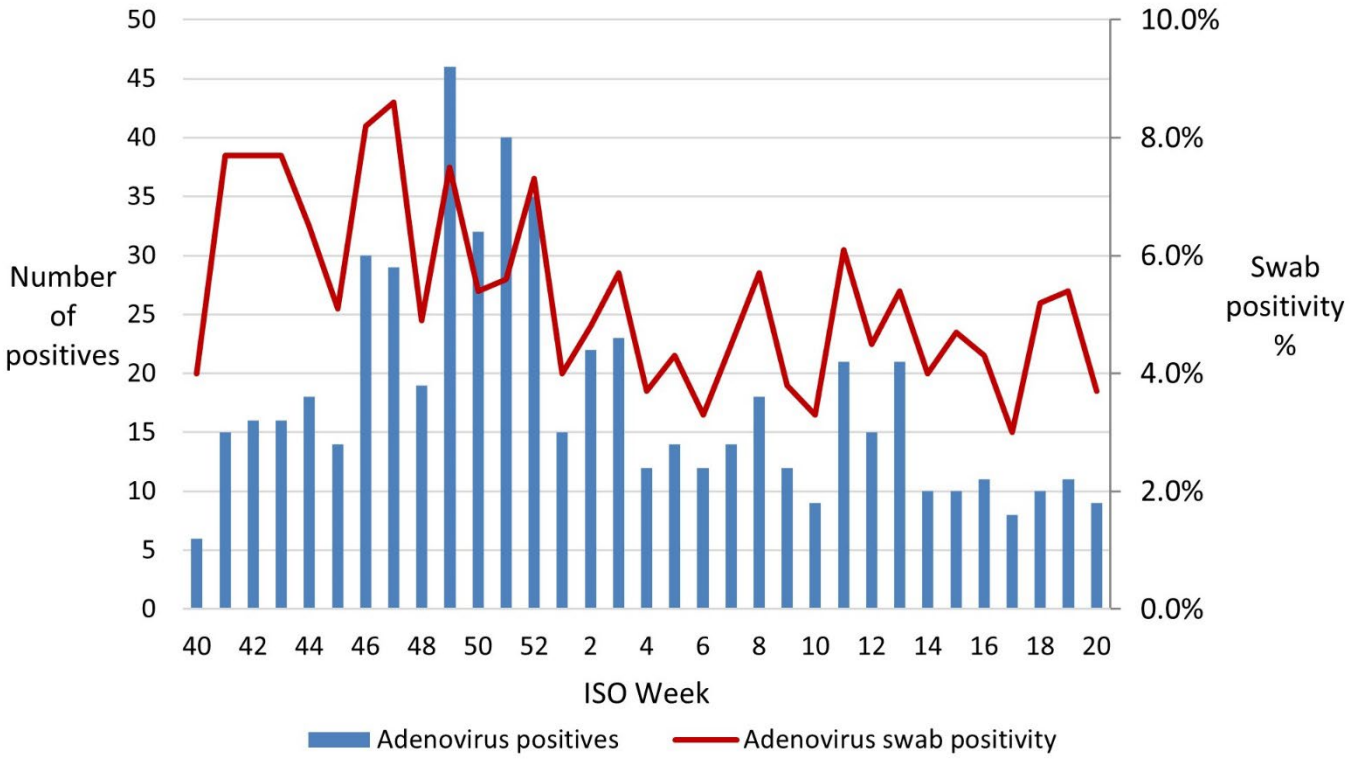
Figure 28b: Odds ratios (with 95% CI) for associations between symptoms and seasonal coronavirus positivity



Adenovirus

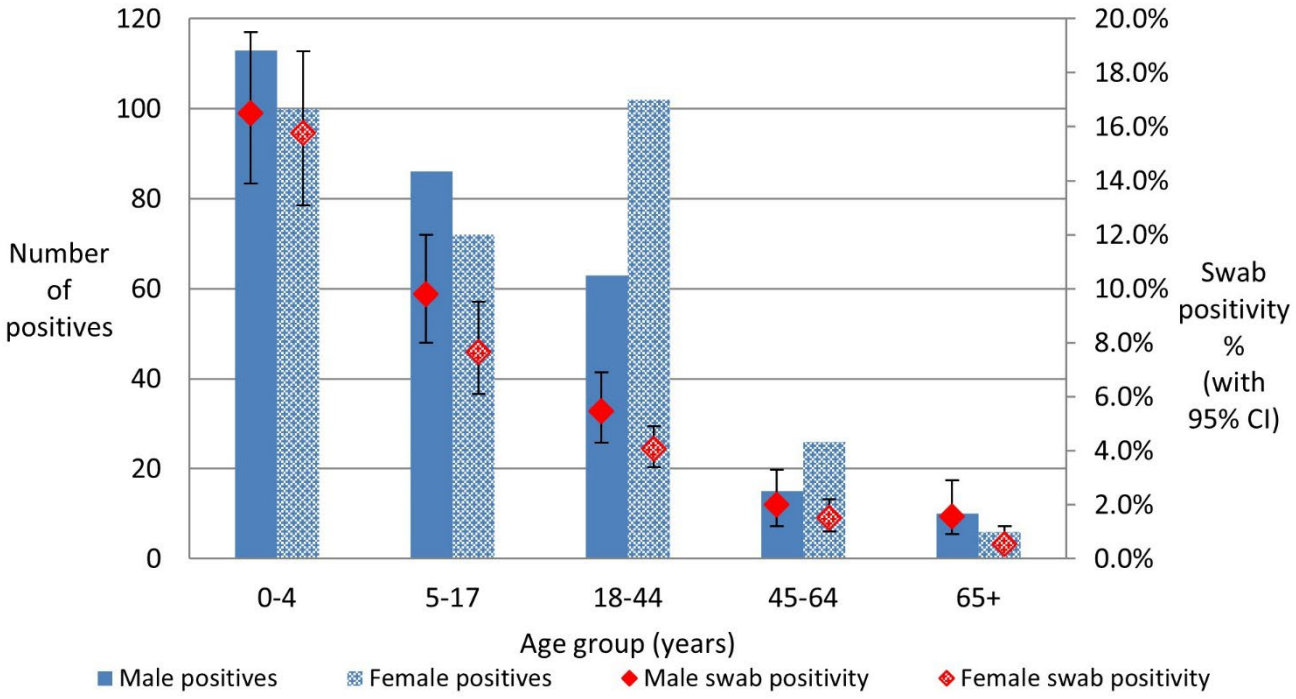
Overall swab positivity for adenovirus was 5.4% (95% CI: 5.0 to 5.8) (Figure 29) and was slightly higher than the **2021/2022 season** at 4.3%. There is no clear seasonality associated with adenovirus.[15]

Figure 29: Number of samples positive for adenovirus and swab positivity over time (week 40, 2022 to week 20, 2023)



For swabs submitted to week 20, overall swab positivity for adenovirus was significantly higher in the 0–4-year age group: 16.5% (95% CI: 13.9 to 19.5) in males and 15.8% (95% CI: 13.1 to 18.8) in females, with a clear decrease in swab positivity as age increased (Figure 30). Swab positivity was higher in males than in females for all age groups, with the lowest swab positivity recorded in females for the 65+ age group at 0.6%.

Figure 30: Number of positive samples and swab positivity for adenovirus, by age and sex



Fever, fatigue and cough were the most common symptoms (Figure 31a). Gastrointestinal symptoms (loss of appetite and nausea/vomiting), as well as fever, were more likely to be reported by patients positive for adenovirus compared to other patients (Figure 31b). Sneezing, cough and shortness of breath were negatively associated with adenovirus.

Figure 31a: Number of positive adenovirus cases reporting symptoms

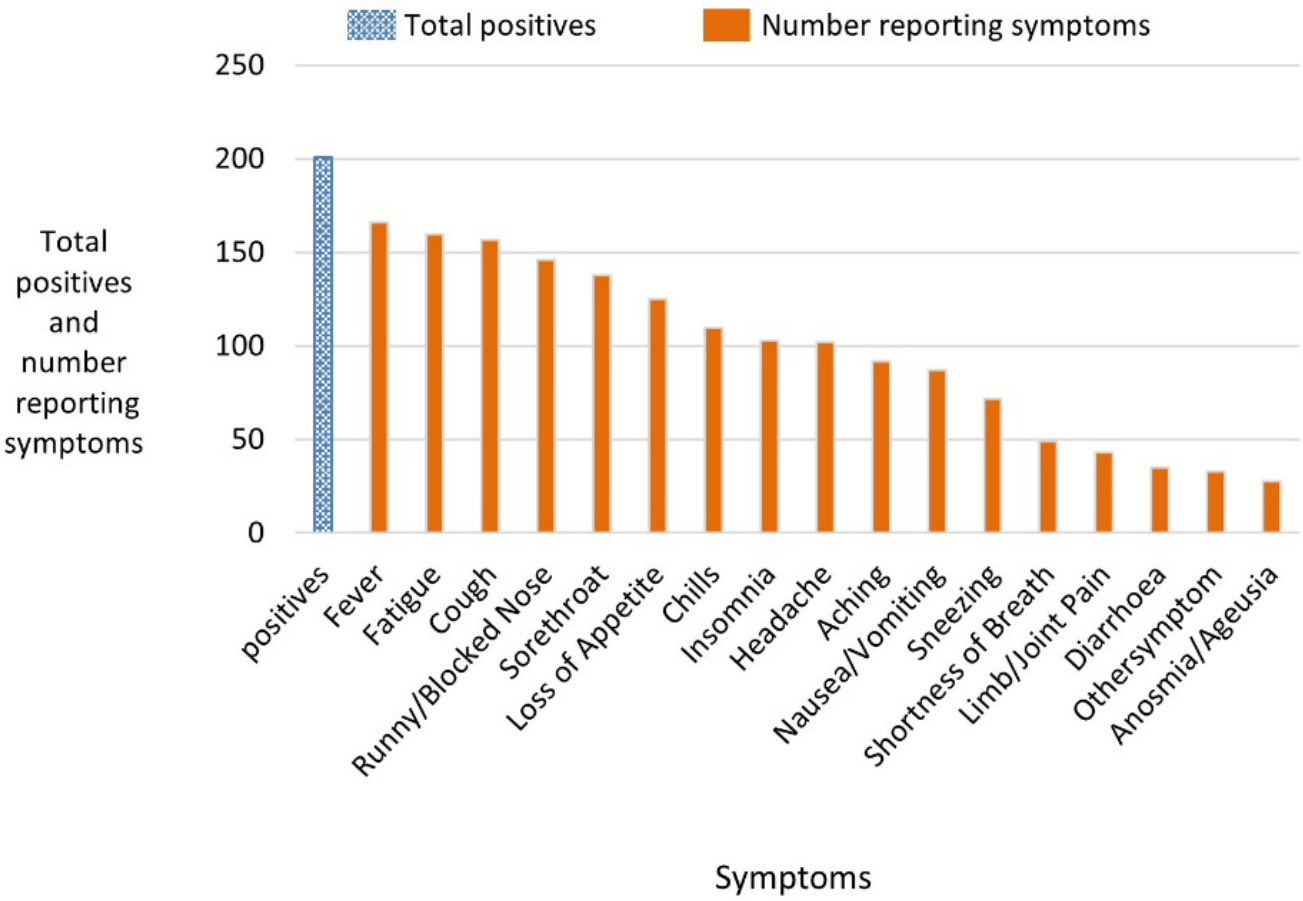
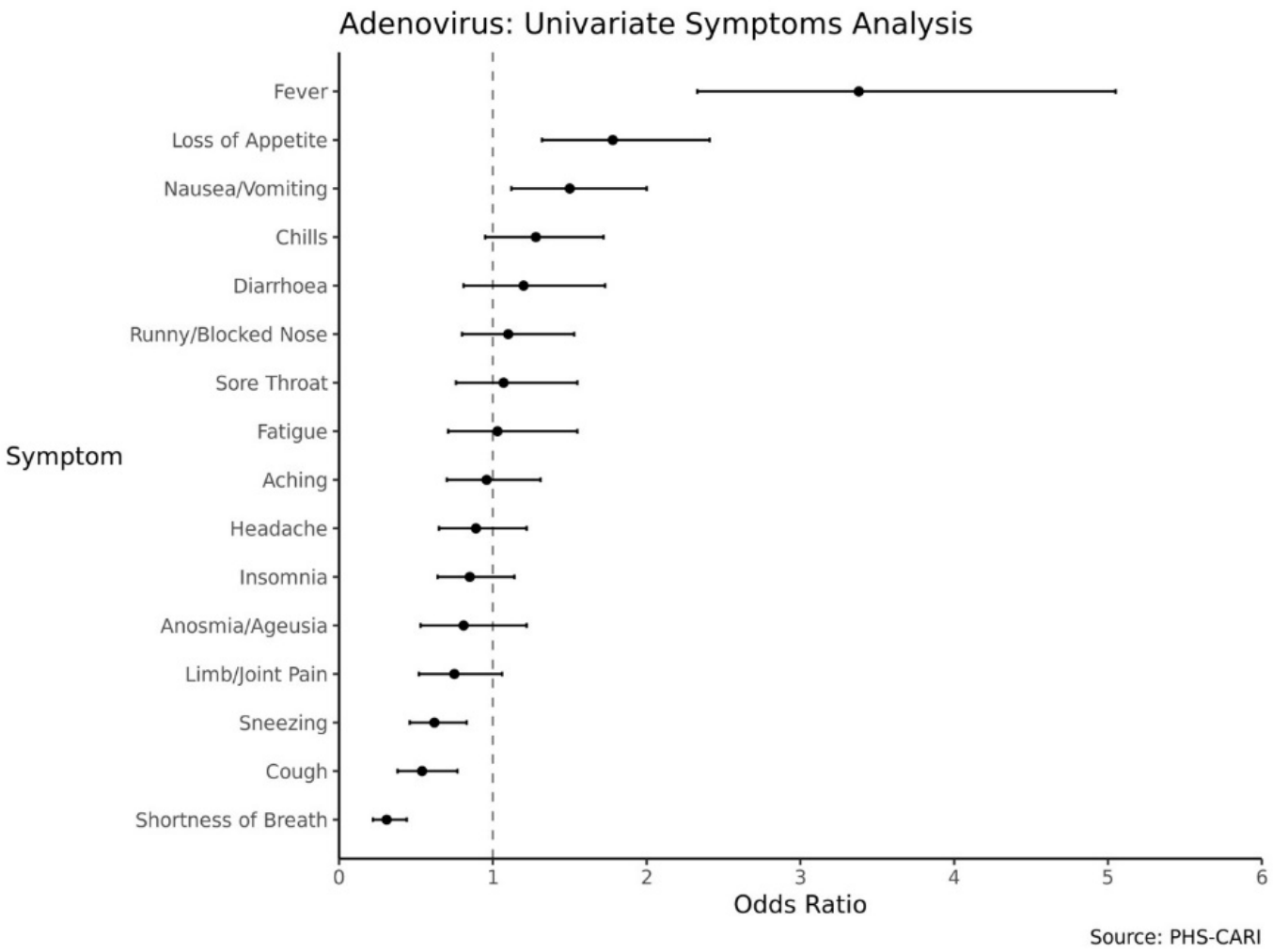


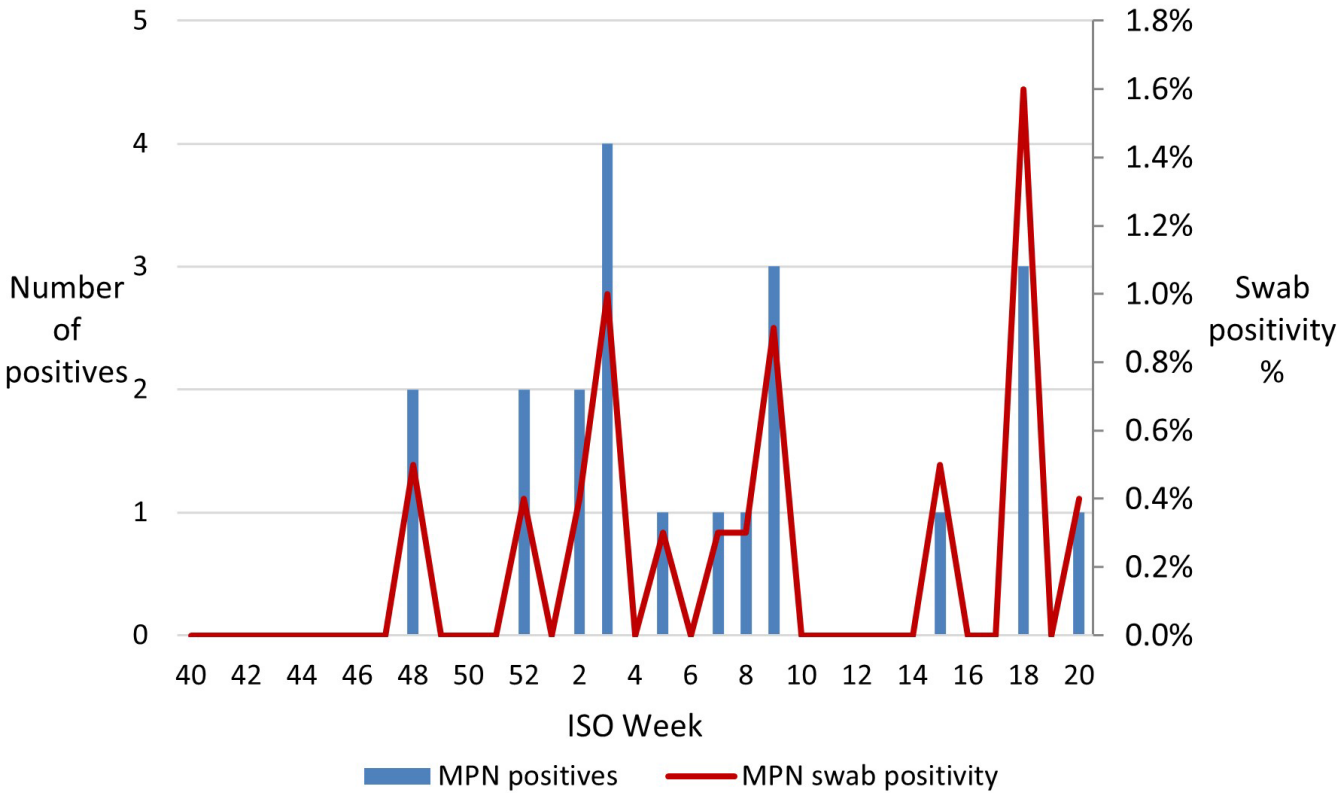
Figure 31b: Odds ratios (with 95% CI) for associations between symptoms and adenovirus positivity



Mycoplasma pneumoniae (MPN)

There were only 21 positive cases of *mycoplasma pneumoniae* throughout the entire season, giving an overall swab positivity of 0.2% (95% CI 0.1 to 0.3) (Figure 32).

Figure 32: Number of samples positive for *mycoplasma pneumoniae* and swab positivity over time (week 40, 2022 to week 20, 2023)



There were only three cases of *mycoplasma pneumoniae* with symptoms data, therefore symptoms analysis was not carried out for this pathogen.

Influenza vaccine effectiveness analyses

One of the objectives of CARI surveillance is to contribute to the evaluation of vaccine effectiveness. CARI data was pooled with data from other European countries in an interim vaccine effectiveness analysis for influenza in February 2023.[15] Here we present vaccine effectiveness analyses for influenza using all available CARI data for the season. **Evaluation of vaccine effectiveness for COVID-19 is reported elsewhere**.

The analyses were carried out for all patients aged 18 years or over who were enrolled in CARI surveillance after 1 September 2022 (when the influenza vaccine programme started), and for whom individual-level vaccination information was available. The test-negative case-control design was used. Cases were defined as patients who tested positive for influenza. For those with repeated test results within a 28-day period, the first positive test was used. Controls were defined as patients who tested negative for influenza (although they could have tested positive for a different pathogen).

There were 1,071 cases of influenza among patients aged 18–64 years, and 165 cases among patients aged over 65 years, with 5,658 and 1,685 controls, respectively. Cases and controls were categorised as unvaccinated (no record of influenza vaccination in the current season or vaccination date on/after date of test), partially vaccinated (vaccinated for influenza within a 14-day period prior to date of test) or vaccinated for influenza (vaccinated more than 14 days prior to test). Odds ratios (ORs) were calculated in logistic regression analyses, with adjustment for age, sex, SIMD deprivation quintile and time in days since study start date. Within a subset of cases and controls, there were also adjustments for the number of chronic conditions reported from the following list: diabetes type 1, diabetes type 2, heart disease, immunosuppression, neurological condition, stroke, asthma and dementia.

Vaccine effectiveness estimates were derived as 100*(1-OR) and 95% confidence intervals were determined. The analyses were repeated for influenza A only and influenza B only, but as there were only two cases of influenza B in the older age group (65+ year old), this analysis is not presented.

Overall influenza vaccine effectiveness in the entire sample of patients enrolled in CARI surveillance was 43.4% for patients aged 18–64 years (Table 1a) and 46.9% for those aged 65 years or over (Table 1b). As expected, the estimates were lower for patients who were partially vaccinated. The vaccine effectiveness estimate for influenza B was available only for patients aged 18–64 years (Table 1e), and this estimate of 79.3% was much higher than the corresponding estimate for influenza A only (37.1%) (Table 1c). Almost all the vaccine effectiveness estimates were higher after adjusting for the total number of reported long-term conditions. This suggests that the presence of other conditions confounds the association, as co-morbidity may increase susceptibility to infection. However, this additional information was available for only a subset of patients. The vaccine effectiveness analyses are in line with those reported mid-season in a wider range of settings in six European countries (and including CARI data), where vaccine effectiveness was higher for influenza B.[16] This was also observed when CARI data were pooled with sentinel primary care data from all other UK nations.

Table 1a: Vaccine effectiveness (VE) analyses for any influenza, 18–64 years

	Cases 1 N (%)	Controls 1 N (%)	VE estimate 1 (95% CI)	VE estimate 2 (95% CI)
Not vaccinated	900 (73.6%)	4,279 (58.6%)	Reference group	Reference group
Partially vaccinated	21 (1.7%)	119 (1.6%)	15.2% (-39.7 to 48.5)	42.2% (-28.5 to 14)
Vaccinated	301 (24.6%)	2,908 (39.8%)	43.4% (32.3 to 52.5)	56.3% (41.2 to 67.5)

Table 1b: Vaccine effectiveness (VE) analyses for any influenza, 65+ years

	Cases 1 N (%)	Controls 1 N (%)	VE estimate 1 (95% CI)	VE estimate 2 (95% CI)
Not vaccinated	32 (19.5%)	317 (18.9%)	Reference group	Reference group
Partially vaccinated	3 (1.8%)	39 (2.3%)	10.0% (-56.1 to 48.1)	75.7% (-136.2 to 97.5)
Vaccinated	129 (78.7%)	1,320 (78.8%)	46.9% (35.1 to 56.5)	54.3% (-11.8 to 81.3)

Table 1c: Vaccine effectiveness (VE) analyses for influenza A, 18–64 years

	Cases 1 N (%)	Controls 1 N (%)	VE estimate 1 (95% CI)	VE estimate 2 (95% CI)
Not vaccinated	783 (71.6%)	4,391 (59.1%)	Reference group	Reference group
Partially vaccinated	20 (1.8%)	120 (1.6%)	19.3% (-34.2 to 51.4)	43.4% (-26.1 to 74.6)
Vaccinated	291 (26.6%)	2,918 (39.3%)	37.1% (24.0 to 47.9)	53.6% (36.5 to 66.1)

Table 1d: Vaccine effectiveness (VE) analyses for influenza A, 65+ years

	Cases 1 N (%)	Controls 1 N (%)	VE estimate 1 (95% CI)	VE estimate 2 (95% CI)
Not vaccinated	32 (19.5%)	317 (18.9%)	Reference group	Reference group
Partially vaccinated	3 (1.8%)	39 (2.3%)	15.9% (-47.5 to 52.1)	75.7% (-136.2 to 97.5)
Vaccinated	129 (78.7%)	1,322 (78.8%)	39.6% (25.2 to 51.2)	54.3% (-11.8 to 81.3)

Table 1e: Vaccine effectiveness (VE) analyses for influenza B, 18–64 years

	Cases 1 N (%)	Controls 1 N (%)	VE estimate 1 (95% CI)	VE estimate 2 (95% CI)
Not vaccinated	119 (91.5%)	4,758 (59.8%)	Reference group	Reference group
Partially vaccinated	1 (0.8%)	131 (1.6%)	-302.5% (-3,137.2 to 50.0)	-
Vaccinated	10 (7.7%)	3,064 (38.5%)	79.3% (56.6 to 90.2)	66.7% (9.5 to 87.7)

1. Adjusted for days since study start, age, sex, SIMD.
2. Adjusted for days since study start, age, sex, SIMD, number of reported conditions.

Discussion

Data derived from the CARI surveillance programme produced a continuous stream of surveillance data that was routinely shared with stakeholders and partner organisations throughout the 2022/2023 season. CARI data have also been used to contribute to estimates of influenza vaccine effectiveness.

The CARI surveillance programme accords with WHO guidance for integrated end-to-end SARS-CoV-2 and influenza sentinel surveillance.[1] Sentinel GP sites across all 14 health boards in Scotland generate more than the recommended 50 to 150 swab samples per week, and this continues all year round. Swabs are tested for ten respiratory pathogens, with all positive SARS-CoV-2 samples also subject to genomic sequencing. Selected influenza positive samples of interest are sequenced as required. Scotland has thereby shown that it can build further upon respiratory surveillance capacities that were strengthened during the COVID-19 pandemic,[2] in order to support rapid and effective response to any emerging threats of the future.

The operational performance of the CARI surveillance system is continually being monitored and improved. The 2023/2024 season will see a focus on increasing the proportion of CARI samples with enhanced surveillance data available, and continuing to ensure that the sentinel GP sites are representative of the Scottish population.

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Contributors

We would like to acknowledge the support for this programme from our sponsors in the Scottish Government, and the various members of each participating GP practice and health board, who have collaborated with us to gather surveillance data over this very busy time.

A list of members of the CARI programme team is included in the **CARI Protocol**. There are also many others who were involved in establishing the CARI programme, but who have returned to their substantive posts.

Further information

Further information and data for this publication are available from the **publication page** on our website.

Open data

Data from this publication is available to download from the **Scottish Health and Social Care Open Data Portal**.

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Appendix: Early access details

Pre-release access

Under terms of the ‘Pre-release access to official statistics (Scotland) order 2008’, PHS is obliged to publish information on those receiving pre-release access (‘pre-release access’ refers to statistics in their final form prior to publication). The standard maximum pre-release access is five working days. Shown below are details of those receiving standard pre-release access.

Standard pre-release access:

Scottish Government Health Department

NHS Board Chief Executives

NHS Board Communication leads

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