Excess primary healthcare consultations in Norway in 2024 compared to pre-COVID-19-pandemic baseline trends

Richard Aubrey White

RichardAubrey.White@fhi.no

Norwegian Institute of Public Health

Beatriz Valcarcel Salamanca

Norwegian Institute of Public Health

Aslaug Angelsen

Norwegian University of Science and Technology

Dinastry Pramadita Zakiudin

Norwegian University of Science and Technology

Aristomo Andries

Norwegian University of Science and Technology

Gunhild Alvik Nyborg

Oslo University Hospital

Research Article

Keywords: COVID-19, primary healthcare, long COVID, PASC, post-acute sequelae of COVID-19, PCC, post COVID-19 condition, Norway, health policy

Posted Date: July 30th, 2025

DOI: https://doi.org/10.21203/rs.3.rs-7184987/v1

Additional Declarations: Competing interest reported. RAW and BVS are employed by the Norwegian Institute of Public Health, which is responsible for providing guidance and recommendations regarding COVID-19 in Norway.

Excess primary healthcare consultations in Norway in 2024 compared to pre-COVID-19-pandemic baseline trends

Richard Aubrey White, Norwegian Institute of Public Health, Oslo, Norway

Beatriz Valcarcel Salamanca, Norwegian Institute of Public Health, Oslo, Norway

Aslaug Angelsen, Norwegian University of Science and Technology, Trondheim, Norway

Dinastry Pramadita Zakiudin, Norwegian University of Science and Technology, Trondheim, Norway

Aristomo Andries, Norwegian University of Science and Technology, Trondheim, Norway

Gunhild Alvik Nyborg, Oslo University Hospital, Oslo, Norway

Corresponding author: Richard Aubrey White (RichardAubrey.White@fhi.no)

Abstract

Background: The risk of post-acute sequelae of COVID-19 is estimated at 3–6% per infection in 2024. Our previous study identified substantial increases in Norwegian primary healthcare consultations in 2023—compared to pre-pandemic levels—for conditions associated with acute and post-acute COVID-19 sequelae. This study extends that analysis to 2024 and includes age- and sex-specific analyses.

Methods: We used data from the Norwegian Syndromic Surveillance System (NorSySS), which captures primary healthcare consultations coded using 101 ICPC-2 codes. Bayesian linear regression models were fitted to 2010–2019 trends, adjusting for population changes, to estimate expected values for 2024. Excess consultations were calculated and stratified by age and sex.

Results: In 2024, there were 17,170,953 consultations. This corresponds to an excess of 836,033 consultations (90% PI: 559,609 to 1,109,762), or a 5.1% relative excess (90% PI: 3.4% to 6.9%) compared to expected levels. The 10 code combinations with largest absolute excess in 2024 were respiratory infections (261,168 excess consultations, 16% relative excess), fatigue (185,774 excess consultations, 63% relative excess), psychological symptom/complaint other (170,943 excess consultations, 79% relative excess), acute stress reaction (162,642 excess consultations, 68% relative excess), depression (119,120 excess consultations, 125% relative excess), hyperkinetic disorder (102,250 excess consultations, 106% relative excess), abdominal pain/cramps general (74,623 excess consultations, 26% relative excess), memory disturbance (36,521 excess consultations, 59% relative excess), conjunctivitis (31,744 excess consultations, 54% relative excess), and infectious disease other/NOS (30,379 excess consultations, 73% relative excess). Deviations from expected pre-pandemic trends worsened dramatically from 2022, coinciding with the Norwegian government's lifting of all COVID-19 preventative measures. Increases typically occurred 3–6 months after COVID-19 waves. Women, children, adolescents, and young adults were disproportionately affected by cognitive issues.

Conclusions: Primary healthcare consultations in 2024 significantly exceeded pre-pandemic expectations, especially for conditions linked to post-acute sequelae of COVID-19. The findings suggest ongoing population-level health impacts associated with repeated SARS-CoV-2 infections, particularly among women, children, adolescents, and young adults. These effects have emerged under a national COVID-19 strategy that does not account for post-acute consequences of SARS-CoV-2 infection.

Contributions to the literature

- Provides empirical evidence of healthcare system shifts under a COVID-19 strategy dependent upon repeated population infection with SARS-CoV-2.
- Quantifies substantial national healthcare burden across all age groups using comprehensive surveillance.
- Documents that many of the conditions with the highest healthcare utilization increases are associated with acute and post-acute COVID-19 sequelae.
- Confirms substantial impacts on women, a group known to be at higher risk of post-acute COVID-19 sequelae.
- Highlights substantial impacts on children and adolescents, a group often excluded from long COVID policy considerations, including vaccine recommendations.

Keywords

COVID-19, primary healthcare, long COVID, PASC, post-acute sequelae of COVID-19, PCC, post COVID-19 condition, Norway, health policy

Background

The COVID-19 pandemic has altered global healthcare utilization patterns, with impacts extending far beyond the acute phase of infection. Post-acute sequelae of COVID-19 (PASC) is now recognized as a systemic, multi-organ disorder, often causing prolonged fatigue, cognitive and neurological dysfunction, cardiovascular complications, and other disabling symptoms (1). The burden of PASC is substantial (1–4); an estimated 400 million individuals require support globally (5), with estimates attributing an annual economic loss of approximately 0.5% of gross domestic product (6,7).

Given this substantial burden, countries have adopted varying approaches to managing ongoing COVID-19 transmission. Norway's current COVID-19 strategy (8), implemented since 2022, differs notably from World Health Organization and other international guidelines (9) and is dependent upon the Norwegian population being repeatedly reinfected with SARS-CoV-2. The Norwegian Institute of Public Health (NIPH) outlines the rationale behind Norway's COVID-19 strategy:

> "It is now mainly population immunity that is keeping the epidemic in check … Stronger measures to limit the spread of infection have two important disadvantages. Firstly, the measures can be resource-intensive, restrict freedoms and weaken the economy and perhaps public health. Secondly, maintaining population immunity depends on the virus circulating in the population" (10).

This strategy creates conditions where repeated SARS-CoV-2 reinfections are common across the population. Although reinfection increases cumulative PASC risk (11–13), the Norwegian government's COVID-19 strategy (8) and NIPH's risk assessment of the strategy focused exclusively on acute consequences, with no mention of PASC (10). Elsewhere, NIPH has claimed that frequent reinfection by SARS-CoV-2 is beneficial for reducing the risk of PASC (14), a view that contrasts with prevailing scientific consensus (15).

Understanding the ongoing risk of PASC is crucial for interpreting healthcare utilization. A recent Norwegian study estimated a 6% PASC risk for triple-vaccinated individuals after a first Omicron infection (16), aligning with international findings (17,18). Results on reinfection are mixed: a UK study found 28% lower odds of PASC after a second versus first infection (11), while U.S. and Canadian data show consistent risk across multiple infections (12,13). Conservative estimates suggest a current per-infection PASC risk of 3–6% in Norway, implying substantial cumulative burden over time.

However, the detection of this burden in routine healthcare data is complicated by Norway's use of the International Classification of Primary Care, 2nd edition (ICPC-2) diagnosis coding system in primary care (19). ICPC-2 codes capture the reason for the patient's encounter or visit to the healthcare provider; approximately half represent diagnoses and half represent symptoms (19,20). Unlike the ICD system, it has not been updated with a specific diagnosis code for PASC. As a result, general practitioners who suspect that their patients suffer from PASC must instead select a diagnosis based on the most dominant symptom, such as fatigue or memory loss (21). This coding limitation may obscure the syndromic nature of PASC and disperse its manifestations across diagnostic categories, complicating efforts to quantify its true impact.

Our previous study found that sick leave and primary healthcare consultations in 2023 exceeded expected trends for conditions consistent with both acute COVID-19 and PASC (22). This study extends that analysis to 2024, identifying diagnostic code combinations with the largest deviations from 2010–2019 baselines, stratified by age and sex. We then assessed whether these deviations plausibly reflected population-level consequences of repeated SARS-CoV-2 infections.

These findings provide crucial data in the Norwegian context, where the national COVID-19 strategy emphasizes the benefits of sustaining population immunity through repeated SARS-CoV-2 infections. Given the global endemicity of SARS-CoV-2, the results also hold broader international relevance (23).

<u>Methods</u>

Data sources

The Norwegian Syndromic Surveillance System (NorSySS; Norwegian: *Det norske syndromiske overvåkingssystemet*) is a public health surveillance system designed to detect outbreaks of infectious diseases and provide early warning for implementation of necessary control measures (24). NorSySS surveils the number of consultations at general practitioners and out-of-hours primary care facilities (22). NorSySS' data source is KUHR (Control and Payment of Health Reimbursements; Norwegian: *Kontroll og utbetaling av helserefusjoner*), which is a system that manages reimbursement claims from healthcare providers and institutions to the state in Norway. The system is owned by the Norwegian Directorate of Health. KUHR is a system within KPR (Municipal Patient and User Register; Norwegian: *Kommunalt pasient- og brukerregister*) that contains data from municipalities about individuals who have applied for, receive, or have received health and care services.

We extracted one outcome measure from NorSySS: The number of primary healthcare consultations per ICPC-2 code combination. A consultation was defined as one interaction with a primary healthcare practitioner that corresponds to one of the following: home visit by a general practitioner (day/night), consultation with a general practitioner (day/night), consultation for being called to the office for immediate help of a patient, e-consultation with a general practitioner and/or emergency room (day). These correspond to the KUHR tariff codes 11ad, 11ak, 2ad, 2ak, 2fk, 2ae. E-consultations with a general practitioner and/or emergency room (night) were not available after July 2023, and hence they were excluded from the entire analysis dataset to ensure consistency.

The extracted data was age- and sex-specific for age groups 5–14, 15–19, 20–29, 30–64, and 65+ for males and females.

Composite ICPC-2 code combinations

Composite ICPC-2 code combinations were extracted directly from NorSySS. In addition to single ICPC-2 codes (e.g., A04), NorSySS includes three predefined composite groupings: COVID-19 (R991 probable/suspected COVID-19 and R992 confirmed COVID-19), gastroenteritis (D11 vomiting, D70 gastrointestinal infection, and D73 gastroenteritis presumed infection), and R** respiratory infections (R01, R02, R03, R04, R05, R07, R08, R09, R21, R24, R25, R27, R29, R33, R71, R72, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R99, R991, and R992). Descriptions of the R codes are available in Additional file 1.

These groupings were previously developed by epidemiologists at NIPH and have been used in routine surveillance for many years. No additional groupings were created in NorSySS or in this analysis, as the system contains only a subset of all possible ICPC-2 codes. Constructing broader diagnostic groupings would therefore not have been appropriate, as they would be incomplete and potentially misleading.

Comparing 2024 against a 2010-2019 baseline

Data was extracted for 101 ICPC-2 code combinations (Additional file 1), representing the number of primary healthcare consultations per year.

We used the data from 2010-2019 to predict expected baselines for 2024, then calculated the excess values for 2024 by subtracting the observed values from the expected baselines.

To calculate the expected/excess values for 2024, one analysis was performed for each ICPC-2 code combination.

To investigate the appropriate model for the expected baseline, three linear regressions were performed on data between 2010-2019:

Model 1:

Outcome: Rate/100k

Covariate: Year as a continuous linear variable with three-way interactions with age and sex.

Model 2:

Outcome: Rate/100k

Covariate: Year as a cubic spline with two degrees of freedom with three-way interactions with age and sex.

Model 3:

Outcome: Rate/100k

Covariate: Year as a cubic spline with three degrees of freedom with three-way interactions with age and sex.

The model with the lowest Akaike Information Criterion (AIC) was selected, and then a Bayesian linear regression was performed using the selected model between 2010-2019, with 4 chains each containing 20,000 iterations. To account for heteroscedasticity, residual standard deviation was allowed to vary by age strata. Model fit was assessed via residuals. For ICPC-2 codes R78 and P03 the residual fit was poor, so the automatic model selection process via AIC was disregarded and year as a continuous linear variable was manually selected. The Bayesian linear regression was implemented using the "brms" package in R, which uses gradient-based Markov chain Monte Carlo algorithms (25–27). The expected baseline for 2020 to 2024 was then calculated by estimating the posterior of the rate/100k. The model results were aggregated up to calculate totals for all ages and all sexes.

The expected baselines were then used to calculate the excess values and corresponding prediction intervals.

The excess values were then restricted to 2024 and corrected for multiple testing using false discovery rates (FDR) with a threshold of 0.05. After FDR correction, significant results with an absolute excess value less than 5,000 were discarded due to not being clinically relevant.

Temporal association with community spread of COVID-19 between 2020 and 2024

As described in our earlier study, there is no consistent data on community spread of COVID-19 in Norway for the entire period of 2020 to 2023. Polymerase chain reaction (PCR) testing and registering of test results were only reliable until the implementation of the "vaccine-only strategy" in 2022, and wastewater ribonucleic acid (RNA) concentration measurements for SARS-CoV-2 were in place since mid-2022, however these measurements were discontinued late 2023 (22).

A proxy therefore had to be created to identify a temporal correlation with community spread of COVID-19. Specifically, we constructed a weekly incidence of COVID-19 hospitalizations in a hypothetical population where no-one is vaccinated, to remove the period effect of pre/post-vaccinated Norway, in the same manner of our previous study (22).

As NIPH ceased reporting the number of patients hospitalized with SARS-CoV-2 in week 25 of 2024, we needed to impute the data between weeks 26 and 52 in 2024. This was done by fitting a linear regression during the period 2020-W14 to 2024-W25, with the outcome being the weekly incidence of COVID-19 hospitalizations in a hypothetical population where no one is vaccinated, and the explanatory variables the proportion of lab positive SARS-CoV-2 (as reported to MSIS laboratory database) interacting with the proportion of primary healthcare consultations for COVID-19 (as reported to NorSySS), both expressed as cubic splines with two degrees of freedom. The remaining data for 2024 (2024-W26 to 2024-W52) was predicted using this fitted model. This variable was then rescaled into a maximum of 1 and a minimum of 0 for interpretation purposes, then summed over quarterly periods (i.e. weeks 1–13, 14–26, 27–39, 40–52).

For each ICPC-2 code combination, the number of consultations per quarterly period were calculated and Pearson's correlation coefficients were then calculated on these quarterly datasets for:

1. Number of primary healthcare consultations versus community spread of COVID-19 in the same quarter.
2. Number of primary healthcare consultations versus community spread of COVID-19 in the previous quarter.
3. Number of primary healthcare consultations versus community spread of COVID-19 two quarters prior.

A significance level of 5% was used for the Pearson's correlation coefficients, without correcting for multiple testing, as they were not utilized as standalone analyses. Rather, they were utilized as descriptive aids to help in the interpretation of the main results—excess/deficit in 2024 versus pre-pandemic trends.

Statistical software

All analyses were performed in R, version 4.4.1 (28), using the *org* (29) and *plnr* (30) packages as the core of the analytical workflow.

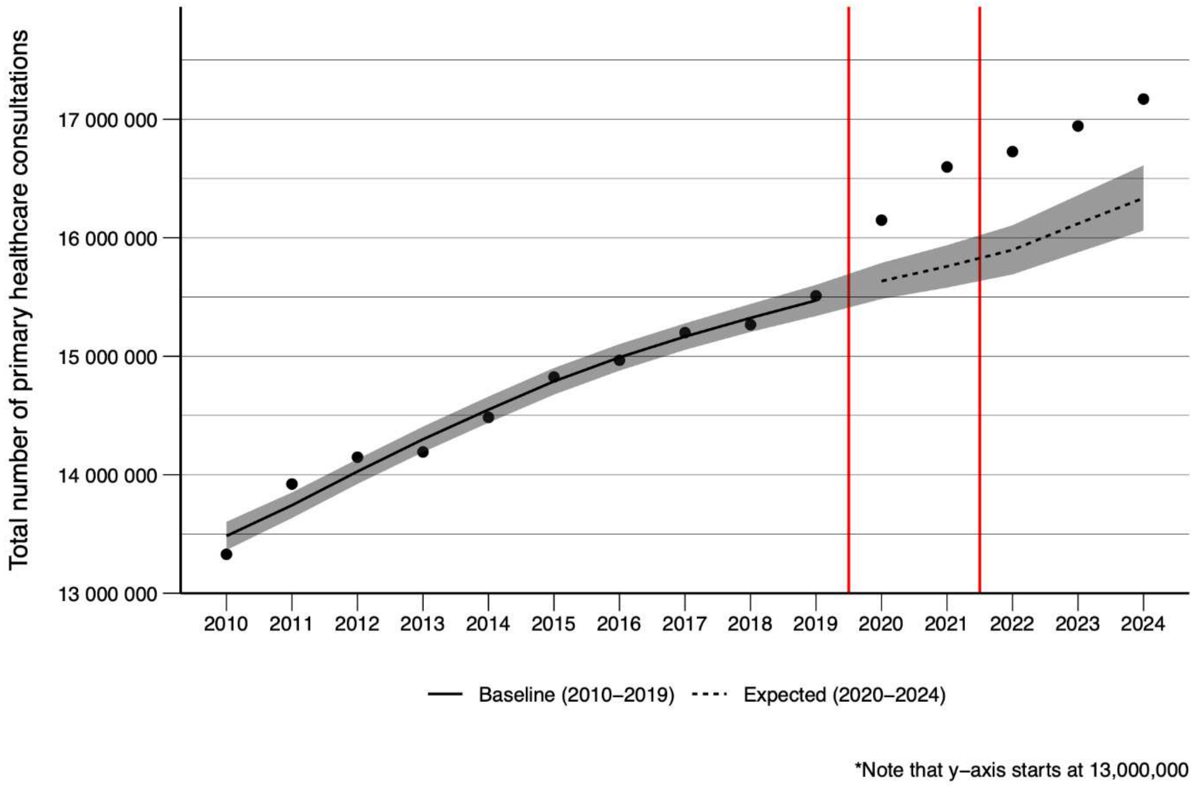

Figure 1. *Total number of primary healthcare consultations per year from 2010–2024, with an expected baseline calculated using data from 2010–2019.*

Results

Total number of primary healthcare consultations

Considering a baseline for 2010 to 2019, it was expected that there would be 16,334,919 (90% PI: 16,061,191 to 16,611,344) total consultations in 2024. We observed 17,170,953, an absolute excess of 836,033 (90% PI: 559,609 to 1,109,762), corresponding to a relative excess of 5.1% (90% PI: 3.4% to 6.9%).

Year	Number of primary healthcare

	consultations for COVID-19 (R991+R992)
2020	488,621
2021	587,252
2022	768,916
2023	166,666
2024	55,576

Table 1. Number of primary healthcare consultations for COVID-19 (R992+R991) per year.

Primary healthcare consultations for COVID-19

The number of primary healthcare consultations for COVID-19 has changed dramatically since 2020; reaching a new low in 2024; 7% of the 2022 peak (Table 1).

Community spread of COVID-19

The linear regression used to model the number of people hospitalized with COVID-19 in a theoretical population with zero immunity had a high R-squared value of 0.87. When observing the community spread index, we observed minimal SARS-CoV-2 spread in 2020 and 2021 (Figure 2). 2022 was defined by three short and intense COVID-19 waves, while 2023 and 2024 were characterized by long periods of medium levels of SARS-CoV-2 transmission (Figure 2). The total area under the curve for the community spread index for the years 2020 through to 2024 were 0.3, 3.7, 22.9, 13.3, and 6.8 respectively.

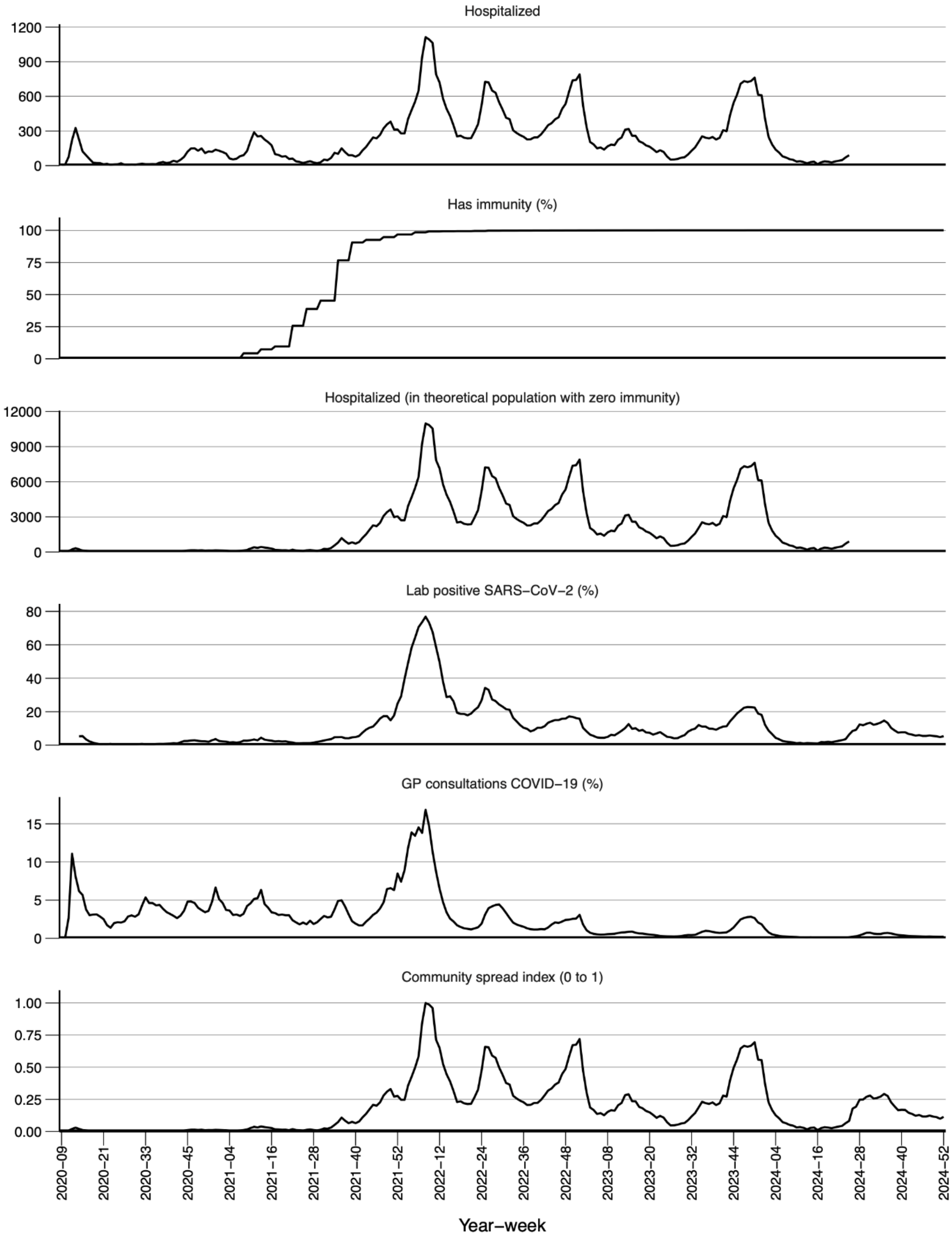

Figure 2. *Different measures of COVID-19 community spread between 2020-W09 and 2024-W52.*

2024 compared to 2010-2019

Results for all ages and sexes are available in Figures 3–4 and Additional file 1.

Examination of the residuals did not reveal any statistical issues with the models (Additional file 2).

The ten ICPC-2 code combinations with the largest excesses were R** (respiratory infections), A04 (weakness/tiredness general), P29 (psychological symptom/complaint other), P02 (acute stress reaction), P03 (feeling depressed), P81 (hyperkinetic disorder), D01 (abdominal pain/cramps general), P20 (memory disturbance), F70 (conjunctivitis infectious), and A78 (infectious disease other/NOS) (Figure 5). We observed no large trend deviations in these ten conditions during or after the 2009/2010 influenza (H1N1) pandemic (Figure 5).

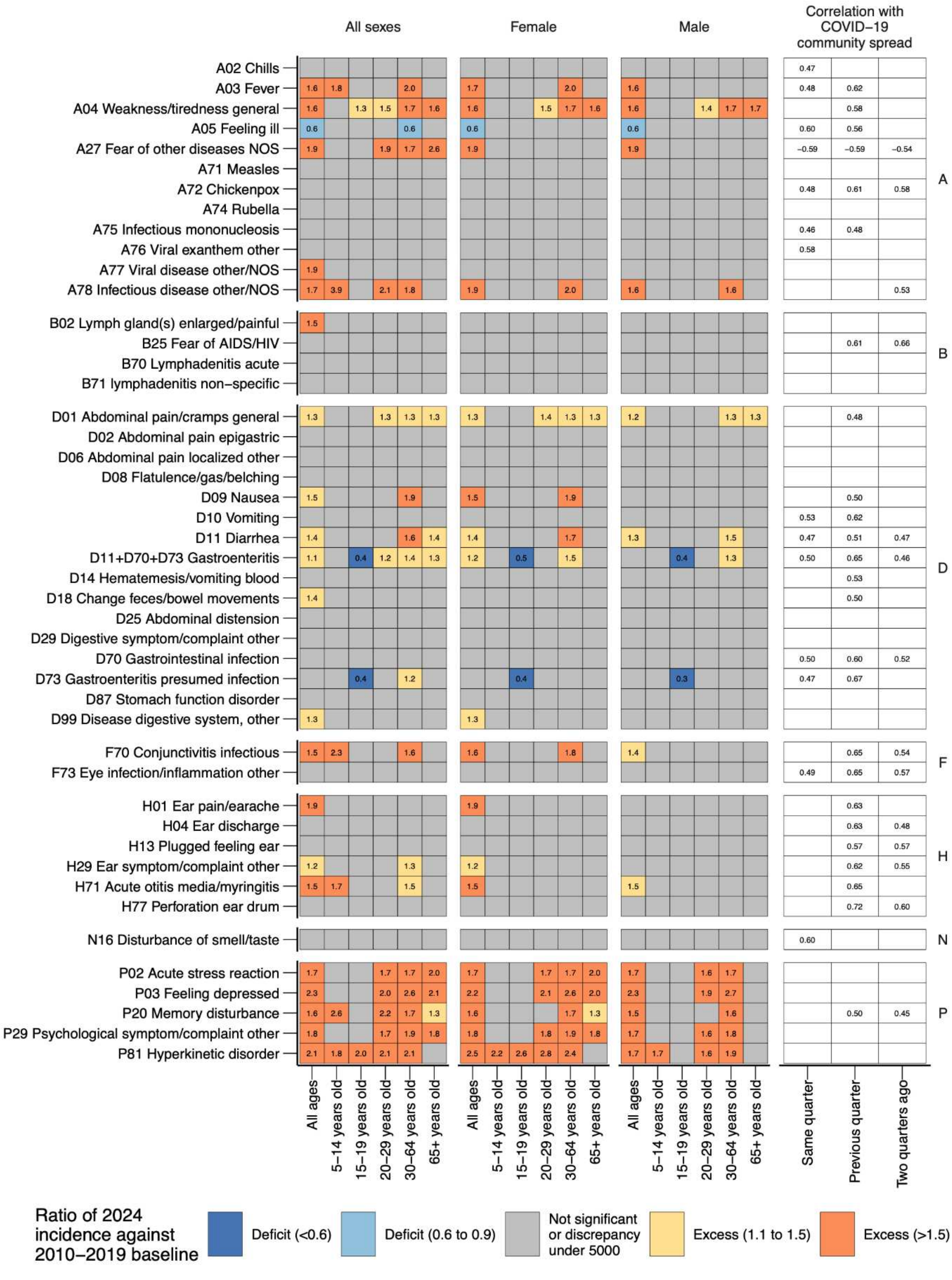

Figure 3. *Ratio of 2024 incidence against 2010–2019 baseline and correlation within COVID-19 community spread for ICPC-2 codes A*, B*, D*, F*, H*, N*, P*.*

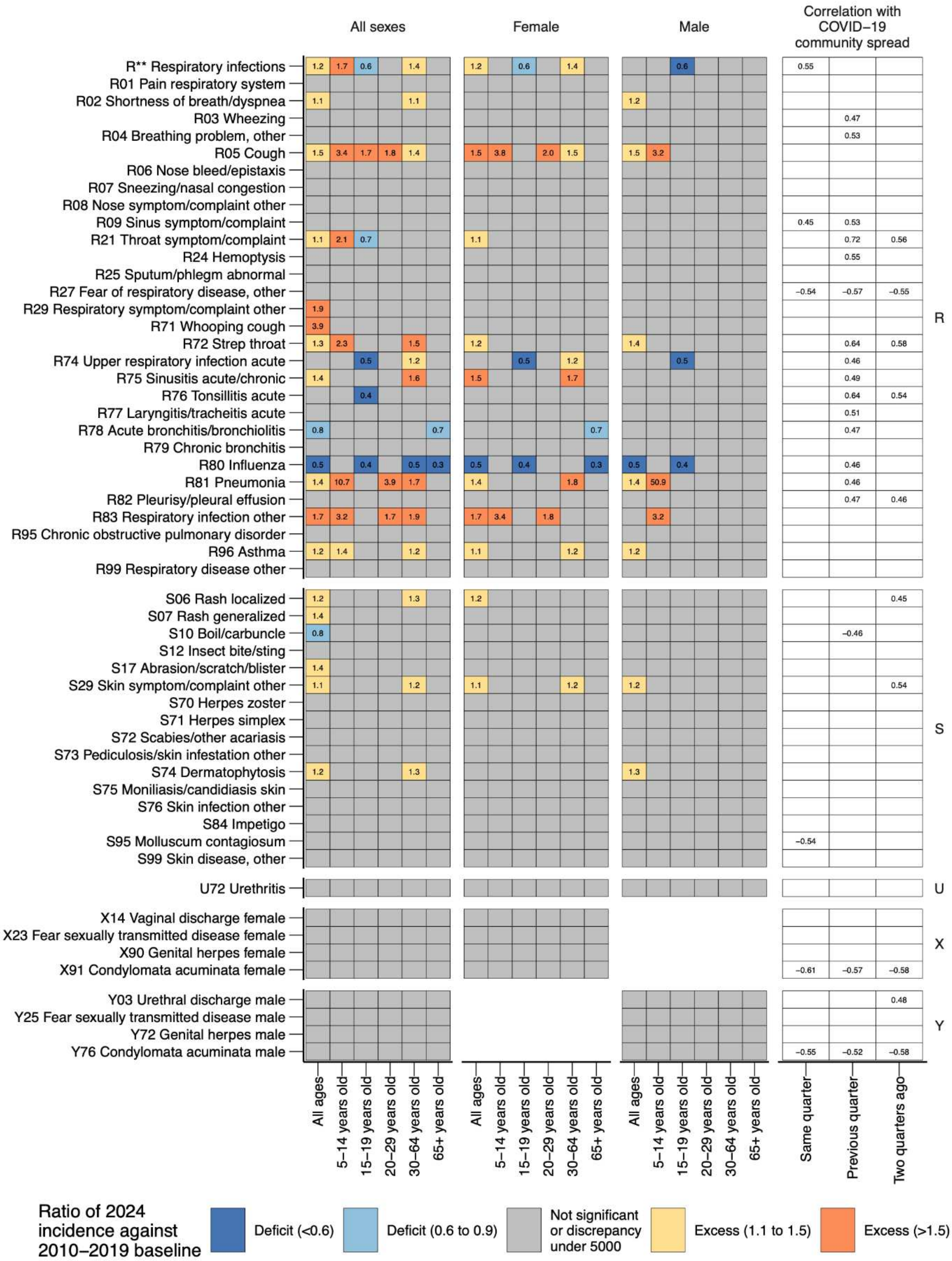

Figure 4. *Ratio of 2024 incidence against 2010–2019 baseline and correlation within COVID-19 community spread for ICPC-2 codes R*, S*, U*, X*, Y*.*

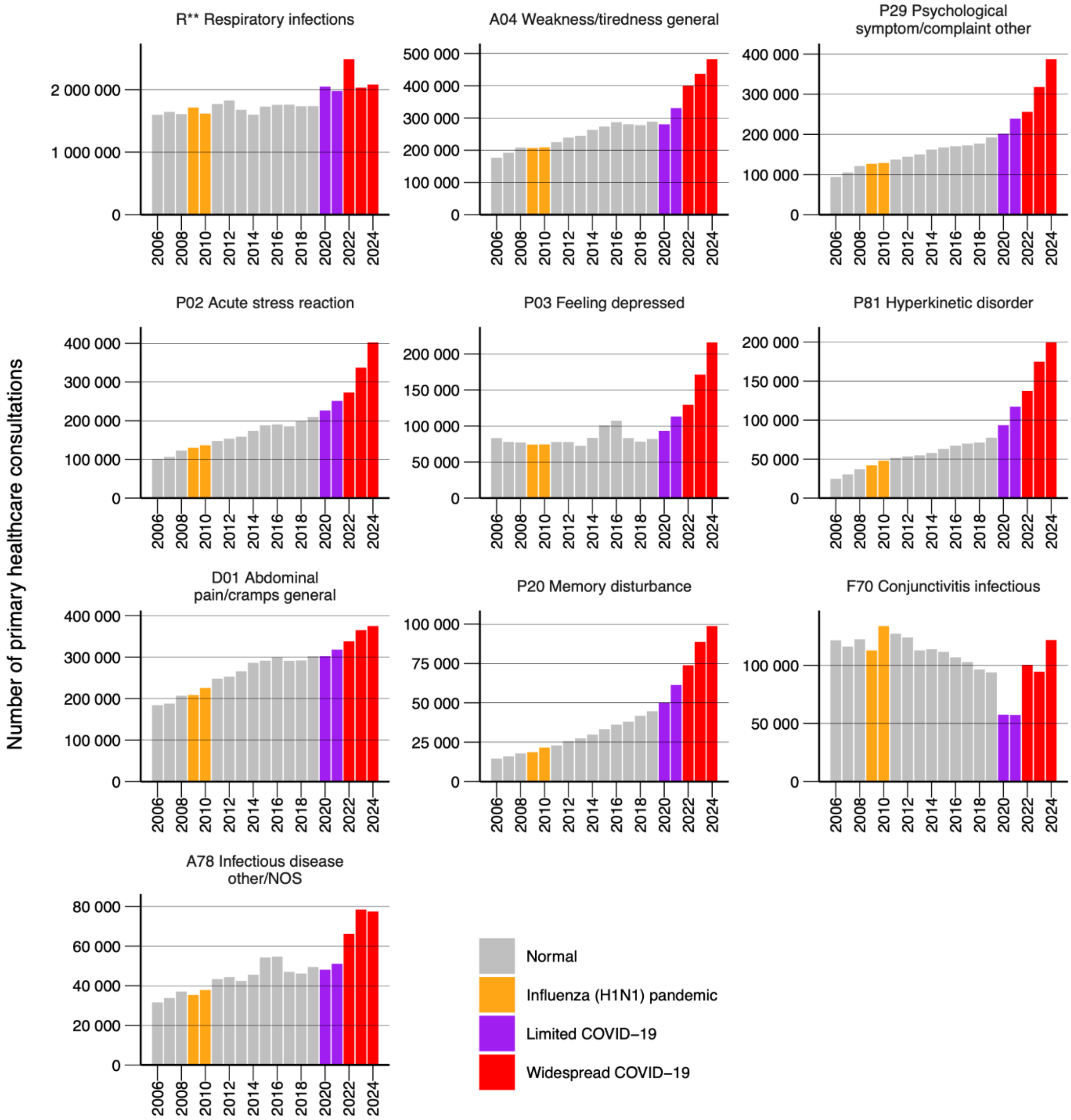

Figure 5. *Number of primary healthcare consultations per year from 2006–2024 for the 10 ICPC-2 code combinations with largest excess in 2024 when compared against the 2010–2019 baseline.*

Respiratory infections

R** is a composite code, consisting of R01, R02, R03, R04, R05, R07, R08, R09, R21, R24, R25, R27, R29, R33, R71, R72, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R99, R991, and R992 (Additional file 1).

Primary healthcare consultations for R** (respiratory infections) in 2024 were 16% (90% PI: 6% to 28%) higher than expected compared to the 2010–2019 baseline, representing 261,168 (90% PI: 110,921 to 412,155) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, all age groups having overlapping confidence intervals in the 10–70% excess range, except for 15–19 years old who had 39% fewer consultations than expected. There were no noticeable differences between males and females (Figure 4 and Additional file 2).

Within the composite code, R05 (cough) was 49% (90% PI: 37% to 64%) higher than expected, corresponding to an additional 84,188 (90% PI: 68,304 to 99,748) consultations. There was noticeable variation between the age groups, with 5–14 year olds at 244%, while 15–19 year olds, 20–29 year olds, and 30–64 year olds having overlapping prediction intervals and central estimates in the 45–80% range, and 65+ year olds were not significantly higher than the expected baseline (8%; 90% CrI: -1% to 18%). There were no noticeable differences between males and females (Figure 4 and Additional file 2). There were no significant temporal correlations with COVID-19 community spread (Figure 4).

Within the composite code, R83 (respiratory infection other) was 67% (90% PI: 30% to 127%) higher than expected, corresponding to an additional 72,000 (90% PI: 41,403 to 100,558) consultations. There was noticeable variation between the age groups, with 5–14 year olds 221% higher than expected, 20–29 years old and 30–64 year olds in the 70-90% range, 65+ years old in the 30% range, and 15–19 year olds were not significantly higher than the expected baseline. There were no noticeable differences between males and females (Figure 4 and Additional file 2). There were no significant temporal correlations with COVID-19 community spread (Figure 4).

Within the composite code, R81 (pneumonia) was 38% (90% PI: 18% to 66%) higher than expected, corresponding to an additional 35,072 (90% PI: 19,493 to 50,602) consultations. There was noticeable variation between the age groups, with 5–14 year olds 969% higher than expected, while 15–19 year olds and 20–29 year olds in the 200–300% range, 30–64 year olds in the 70% range, and 65+ year olds were not significantly higher than the expected baseline. There were no noticeable differences between males and females (Figure 4 and Additional file 2). There were significant temporal correlations with COVID-19 community spread in the previous quarter (r=0.46) (Figure 3).

Within the composite code, R72 (strep throat) was 31% (90% PI: 18% to 46%) higher than expected, corresponding to an additional 11,300 (90% PI: 7,308 to 15,243) consultations. There was noticeable variation between the age groups, with 5–14 year olds and 65+ year olds in the 110–130% range, while 30–64 year olds at 53%, and 15–19 year olds and 20–29 year olds were not significantly higher than the expected baseline. There were no noticeable differences between males and females (Figure 4 and Additional file 2). There were significant temporal correlations with COVID-19 community spread in the previous quarter (r=0.64), and two quarters prior (r=0.58) (Figure 3).

Within the composite code, R71 (whooping cough/pertussis) was 289% (90% PI: 215% to 401%) higher than expected, corresponding to an additional 6791 (90% PI: 6240 to 7317) consultations. There were no noticeable differences between neither sexes nor ages (Figure 4 and Additional file 2). There were no significant temporal correlations with COVID-19 community spread (Figure 4).

Weakness/tiredness general (Fatigue) (A04)

Primary healthcare consultations for A04 (weakness/tiredness general) in 2024 were 63% (90% PI: 55% to 73%) higher than expected compared to the 2010–2019 baseline, representing 185,774 (90% PI: 170,150 to 201,456) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with 30–64 year olds (72%; 90% PI: 59% to 87%) having the largest relative excess. There were no noticeable differences between males and females (Figure 3 and Additional file 2).

There were significant temporal correlations with COVID-19 community spread in the previous quarter (r=0.58) (Figure 3).

Deviation from expected pre-pandemic trends began in 2021, but worsened dramatically from 2022 to 2024 (Additional file 2).

Psychological symptom/complaint other (P29)

Primary healthcare consultations for P29 (psychological symptom/complaint other) in 2024 were 79% (90% PI: 71% to 88%) higher than expected compared to the 2010–2019 baseline, representing 170,943 (90% PI: 160,770 to 181,068) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with those 20 years and above in the 70–90% range, while 5–14 year olds were at 40%, followed by 15–19 year olds at 11%. There were no noticeable differences between males and females (Figure 3 and Additional file 2).

There were no significant temporal correlations with COVID-19 community spread (Figure 3), however, there was a borderline significant (p=0.09) temporal correlation with COVID-19 community spread in the previous quarter (r=0.39).

Deviation from expected pre-pandemic trends began in 2020, noticeably deviating in 2021, and dramatically worsened in 2023 and 2024 (Figure 4).

Acute stress reaction (P02)

Primary healthcare consultations for P02 (acute stress reaction) in 2024 were 68% (90% PI: 59% to 78%) higher than expected compared to the 2010–2019 baseline, representing 162,642 (90% PI: 148,802 to 176,340) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with 5–14 year olds, 20–29 year olds, 30–64 year olds, and 65+ year olds having overlapping prediction intervals and central estimates in the 65–100% range, while 15–19 year olds were not significantly higher than the expected baseline (0%; 90% PI: -11% to 14%). There were no noticeable differences between males and females (Figure 3 and Additional file 2).

There were no significant temporal correlations with COVID-19 community spread (Figure 2), however, there was a borderline significant (p=0.11) temporal correlation with COVID-19 community spread in the previous quarter (r=0.37).

Deviation from expected pre-pandemic trends began in 2020, noticeably deviating in 2021, and dramatically worsened in 2023 and 2024 (Figure 4).

Depression (P03)

Primary healthcare consultations for P03 (feeling depressed) in 2024 were 125% (90% PI: 95% to 166%) higher than expected compared to the 2010–2019 baseline, representing 119,120 (90% PI: 104,224 to 133,616) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with 20+ year olds being in the 100–160% range, followed by 5–14 year olds (53%; 90% PI: 38% to 71%), while 15–19 year olds were not significantly higher than the expected baseline (14%; 90% PI: -3% to 38%). There were no noticeable differences between males and females (Figure 3 and Additional file 2).

There were no significant temporal correlations with COVID-19 community spread (Figure 2), however, there was a borderline significant (p=0.10) temporal correlation with COVID-19 community spread in the previous quarter (r=0.38).

Hyperkinetic disorder (P81)

Primary healthcare consultations for P81 (hyperkinetic disorder) in 2024 were 106% (90% PI: 99% to 113%) higher than expected compared to the 2010–2019 baseline, representing 102,250 (90% PI: 99,080 to 105,404) additional consultations, and remained statistically significant after false discovery rate corrections. There was some variation between the age groups, with 5–14 year olds at 85%, while 15–19 year olds, 20–29 year olds, 30–64 year olds, and 65+ year olds had overlapping prediction intervals and central estimates in the 95–115% range (Figure 4 and Additional file 2). Furthermore, females had double to triple the relative excess of males, depending on the age group (Figure 4 and Additional file 2).

There were borderline significant temporal correlations with COVID-19 community spread with the previous quarter (p=0.08; r=0.40) and two quarters prior (p=0.08; r=0.41) (Figure 2).

Deviation from expected pre-pandemic trends began in 2020, noticeably deviating in 2021, and continued to dramatically worsen from 2022 to 2024 (Additional file 2).

Abdominal pain/cramps general (D01)

Primary healthcare consultations for D01 (abdominal pain/cramps general) in 2024 were 26% (90% PI: 21% to 32%) higher than expected compared to the 2010–2019 baseline, representing 74,623 (90% PI: 62,458 to 86,722) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with 20–29 year olds, 30–64 year olds, and 65+ year olds having overlapping prediction intervals and central estimates in the 30–35% range, while 5–14 year olds and 15–19 year olds were not significantly higher than the expected baseline (Figure 3 and Additional file 2).

There were significant temporal correlations with COVID-19 community spread in the previous quarter (r=0.48) (Figure 3). Deviation from expected pre-pandemic trends began in 2020, noticeably deviating in 2021, and worsened in 2023 and 2024 (Additional file 2).

Memory disturbance (P20)

Primary healthcare consultations for P20 (memory disturbance) in 2024 were 59% (90% PI: 54% to 64%) higher than expected compared to the 2010–2019 baseline, representing 36,521 (90% PI: 34,704 to 38,339) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with 5–14 year olds (163%; 90% PI: 138% to 193%) having the largest relative excess, followed by 20–29 year olds (122%; 90% PI: 105% to 141%), 15–19 year olds (106%; 90% PI: 95% to 117%), 30–64 year olds (67%; 90% PI: 61% to 74%), and 65+ year olds (30%; 90% PI: 24% to 36%). Females had approximately double the excess of males in the age groups 5–14 years old, 15–19 years old, and 20–29 years old (Figure 3 and Additional file 2).

There were significant temporal correlations with COVID-19 community spread in the previous quarter (r=0.50) and in two quarters prior (r=0.45) (Figure 3).

Deviation from expected pre-pandemic trends began in 2020, noticeably deviating in 2021, and continued to dramatically worsen from 2022 to 2024 (Figure 4).

Conjunctivitis (F70)

Primary healthcare consultations for F70 (conjunctivitis infectious) in 2024 were 54% (90% PI: 48% to 60%) higher than expected compared to the 2010–2019 baseline, representing 31,744 (90% PI: 29,364 to 34,094) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with 5–14 year olds at 135%, followed by 20–64 year olds at 55–75%, 65+ year olds at 19%, and 15–19 year olds at 1%. Females (65%; 90% PI: 57% to 73%) had higher excess than males (39%; 90% PI: 30% to 49%) (Figure 3 and Additional file 2).

There were significant temporal correlations with COVID-19 community spread in the previous quarter (r=0.65), and two quarters prior (r=0.53) (Figure 3).

Infectious disease other/no obvious source (A78)

Primary healthcare consultations for A78 (infectious disease other/NOS) in 2024 were 73% (90% PI: 51% to 102%) higher than expected compared to the 2010–2019 baseline, representing 30,379 (90% PI: 24,345 to 36,342) additional consultations, and remained statistically significant after false discovery rate corrections. There was noticeable variation between the age groups, with 5–14 year olds at 288%, followed by 15–64 year olds at 80–110%, and 65+ year olds at 25%. There were no noticeable differences between males and females (Figure 3 and Additional file 2).

There were significant temporal correlations with COVID-19 community spread two quarters prior (r=0.53) (Figure 3).

Discussion

In 2024, primary healthcare consultations in Norway exceeded pre-pandemic expectations by approximately 501,000 visits, representing a 3.0% relative excess. The largest absolute increases were observed for respiratory infections, fatigue, psychological complaints, acute stress reactions, depression, and cognitive impairment. Women, children, adolescents, and young adults were disproportionately affected by cognitive issues. For several conditions, consultation volumes began diverging from pre-pandemic baselines after 2021/2022, with increases typically occurring 3–6 months after COVID-19 waves.

This is an observational study of aggregated temporal trends, so causal attribution is not possible. However, given that the national COVID-19 strategy is predicated on repeated SARS-CoV-2 reinfections, and that official risk assessments do not account for PASC, this unique situation raises concerns about the long-term health impacts of sustained SARS-CoV-2 circulation at the population level. Therefore, the discussion examines whether existing literature supports the interpretation that excess primary healthcare consultations in 2024 could be partially attributed to PASC.

Clinical perspectives and diagnostic coding in Norway

Despite growing international recognition of PASC as a multi-organ disorder with serious functional consequences, prevailing perspectives within the Norwegian healthcare system may contribute to its under-recognition. In particular, PASC is often framed as a psychosocial condition—driven more by anxiety and perception than by persistent physiological damage (31–33). The “Oslo Chronic Fatigue Consortium”—an influential group of mostly Norwegian clinicians and researchers—has described PASC and other post-infectious disorders as “likely to reflect the brain's response to a range of biological, psychological, and social factors, rather than a specific disease process” (34). Similar views have dominated official guidelines and medical literature for decades—without yielding significant clinical progress or improved outcomes for patients with post-infectious conditions (35–37). This psychosocial framing of PASC may influence clinical practice, diagnostic coding, and how symptoms are perceived by both patients and providers.

These perspectives intersect with structural limitations in diagnostic coding. ICPC-2, used by primary healthcare in Norway, does not include a specific code for PASC. Clinicians are instead required to code the patient's most dominant symptom. In July 2023, the Norwegian Directorate of Health issued guidance to "dual code" both the most dominant symptom along with R992 (confirmed COVID-19) to flag PASC (21). However, this practice appears uncommon: in 2024, only 2,730 of the 479,101 consultations for fatigue were dual-coded with R992. This suggests that the guidance has seen limited uptake in practice. Whether this reflects low awareness, limited clinical suspicion, or prevailing beliefs that PASC is rare or primarily psychosocial in origin remains unclear. Regardless, the result is that potential post-COVID sequelae may not be explicitly documented in registry data.

These coding practices and clinical framings may help explain the patterns observed in our data, where symptoms consistent with PASC appear under a range of diagnostic categories rather than being recognized as part of a coherent syndrome.

The question of long-term immunodeficiency and immune dysregulation after COVID-19

Immunological studies have reported immune dysregulation and dysfunction via several different cell lines and mechanisms, lasting for months or longer after COVID-19, with higher risk after severe acute infection and in patients with PASC (38–41). It is still unclear how this translates into alterations in epidemiological patterns. However, epidemiological studies also report higher incidences of different infectious diseases in the months following COVID-19 (42), observations that are consistent with expected observations if the immune dysfunction leaves some people more susceptible to other infections after a SARS-CoV-2 infection (43).

One study in the US showed that COVID-19 was associated with a significantly increased subsequent risk of RSV among children aged 0-5 years in both 2022 and 2021, with the authors postulating that their findings "suggest that COVID-19 contributed to the 2022 surge of RSV cases in young children through the large buildup of COVID-19-infected children and the potential long-term adverse effects of COVID-19 on the immune and respiratory system” (44). A study from Thailand found that COVID-19 pneumonia was strongly associated with a higher hazard of detectable active pulmonary tuberculosis, and it was likely that this hazard was not fully explained by diagnostic bias (45). A test-negative analysis of 836,913 US veterans found increased rates of various infections in the 12 months after an acute SARS-CoV-2 infection (42). A study from Israel found that patients infected with SARS-CoV-2 were at increased risk for streptococcal tonsillitis compared to those who tested negative (46). Invasive group A streptococcus is among the several other infectious diseases that have also seen sharp increases in incidence (47).

A US study of approximately 1.5 million people found COVID-19-positive patients were more likely to develop new-onset conjunctivitis compared to COVID-19-negative controls (48). An Israeli study found that unvaccinated 0–4 year olds and 5–11 year olds who tested PCR-positive for SARS-CoV-2 were significantly more likely to have conjunctivitis than their peers who tested PCR-negative for SARS-CoV-2 (46).

In Germany, one study found a sharp increase in the incidence of complicated otitis after the cessation of comprehensive measures against COVID-19 (49). Several studies have suggested that otitis media should be considered as a symptom associated with COVID-19 (50–52).

From this literature, one could expect to see an increase in primary health care consultations for infectious diseases in Norway for the years after 2022, which is consistent with the findings from this study, particularly pertaining to the R** respiratory codes.

For pneumonia, an internal investigation was launched inside NIPH, and found that the large excess of primary healthcare consultations for R81 in 2024 corresponded to a mycoplasma pneumoniae epidemic.

Fatigue

Fatigue is one of the most well-documented post-acute sequelae of COVID-19 (15,53).

A systematic review of 50 controlled studies including over 14 million participants found that non-hospitalized COVID-19 patients had significantly increased risks of fatigue (RR 1.58; 95% CI: 1.25 to 1.96) (54). Norwegian studies have also consistently demonstrated this association: one study of more than 57,000 participants found that even among people with three vaccine doses, Omicron infection was associated with a 70% higher risk of fatigue lasting at least three months (16). Among those with only two vaccine doses, the risk was even higher (178% for women and 107% for men). A separate Norwegian study of 140,000 participants showed that people who tested positive for the Delta and Omicron variants of SARS-CoV-2 were more likely to seek healthcare for fatigue in the 126 days post-infection compared to those who tested negative (55).

ME/CFS is a serious complication that develops in a subset of patients with PASC (56). A study commissioned by the Norwegian Directorate of Health identified that a variety of ICPC-2 codes are used by Norwegian primary care physicians when suspecting ME/CFS; these codes include A04 (weakness/tiredness general) (57). The Norwegian Labour and Welfare Administration found that people with medically certified sick leave due to COVID-19 had substantially increased risks of subsequent sick leave for A04 (weakness/tiredness general, 182% increased risk) in the following 12 weeks compared to those on sick leave for non-COVID-19 reasons (58).

Psychological symptom/complaint other

The ICPC-2 code P29 (Psychological symptom/complaint other) is used for psychological issues without an obvious source (22). For example, the Norwegian Directorate of Health's guidance to primary healthcare doctors regarding "burnout" is to record it under P29 (59). When using the Norwegian Directorate of Health's "Find Code" tool, searching for the term "slitenhet" (Norwegian for "*fatigue"*) returns the code P29 as the only suggestion (60). Norwegian primary care physicians employ various ICPC-2 codes when suspecting ME/CFS,. These codes include P29 (psychological symptom/complaint other) (57).

In the Norwegian Labour and Welfare Administration's study, people with medically certified sick leave due to COVID-19 had substantially increased risks of subsequent sick leave for P29 (psychological symptom/complaint other, 18% increased risk) in the following 12 weeks compared to those on sick leave for non-COVID-19 reasons (58).

Acute stress reaction

The ICPC-2 code P02 is used for:

> "a reaction to a stressful life event or a significant change in life that requires a major adjustment, either as an expected response to the event or as an inappropriate response that interferes with daily coping and results in impaired social functioning, with recovery within a limited time" (61).

P02 (acute stress reaction) is among the ICPC-2 codes that Norwegian primary care physicians employ when suspecting ME/CFS (57).

People with medically certified sick leave due to COVID-19 were 25% more likely to be on sick leave for P02 in the following 12 weeks than people with medically certified sick leave for not COVID-19 (58).

Depression

A pandemic has multiple disruptive effects on society that likely affects the population's mental health. In addition, Norway experienced a cost-of-living-crisis from 2022 to 2024.

International studies show evidence of increased risk of depression after SARS-CoV-2 infection (53,62). One study of over 81 million participants found evidence for substantial neurological and psychiatric morbidity in the 6 months following COVID-19 (63). Another study of over 10 million participants found that COVID-19 was associated with an increased risk of many mental health disorders, including depressive disorders (64). A small study found that biomarkers during acute SARS-CoV-2 infection predicted long-term psychiatric symptoms, including depression (65) and symptoms of mood disorders have been found to correlate with other neurological symptoms and organ damage post COVID-19 (66). The current evidence on the pathophysiological basis of neuroimmunological PASC points to neuroinflammation as central (67), and a direct link between mood disorders and PASC cannot be ruled out. However, patients experiencing symptoms of PASC often report problems in their everyday life functioning and a lack of support from healthcare professionals, factors that may also contribute to an increased prevalence of mood disorders in PASC.

A Norwegian study found that among people with three vaccine doses, Omicron infection was not associated with an increased relative risk of depression with a duration of at least three months (16), and another Norwegian study showed that people who tested positive for the Delta and Omicron variants of SARS-CoV-2 were no more likely to seek healthcare for anxiety/depression in the 126 days post-infection compared to those who tested negative (55). However, people with medically certified sick leave due to COVID-19 were 34% more likely to be on sick leave for P76 (depressive disorder) in the following 12 weeks than people with medically certified sick leave for not COVID-19 (58). Tacquet et al. found similar neurological and psychiatric outcomes during the delta and omicron waves, suggesting that the burden on the health-care system from these complaints might continue (62).

Cognitive impairment (hyperkinetic disorder and memory disturbance)

Cognitive impairment, particularly memory and concentration difficulties (often referred to as “brain fog”), represents another well-established post-acute sequela of COVID-19 (15,53). The aforementioned systematic review of 50 controlled studies found that non-hospitalized COVID-19 patients had significantly increased risks of poor memory (RR 2.74; 95% CI: 1.02 to 7.39) and poor concentration (RR 4.86; 95% CI: 2.67 to 8.85) (54). Norwegian data corroborate these findings: the aforementioned study of 57,000 participants found that among people with three vaccine doses, Omicron infection was associated with 140% increased risk of poor memory and 100% increased risk of brain fog lasting at least three months (16). Another Norwegian study of 188,137 participants reported that “patient-reported memory function … was numerically worse at several time points up to 36 months after a positive SARS-CoV-2 test than after a negative test” (68).

Modern society has seen significant changes in the use of digital tools, social media platforms, and related structural shifts, which some researchers have suggested may contribute to the increasing prevalence of ADHD/ADD (69). However, the timing of these developments is critical. In Norway, screen time among children and adolescents rose steadily from 2014 to 2021 but appears to have stabilized—or even declined—between 2021 and 2024 (70). Since our study finds the largest increases in consultations for cognitive impairment occurring after 2021, this trend suggests that other likely factors may account for the observed rise.

While evidence regarding whether SARS-CoV-2 infection directly increases the risk of ADHD/ADD is sparse and somewhat conflicting (71,72), it is well documented that neurological and psychological sequelae from COVID-19 often manifest as lack of concentration, impaired mental flexibility as an executive subfunction, and impaired working memory and general reactivity (73,74), symptoms that are central in ADHD/ADD. Since the rate of SARS-CoV-2 infections have been so high during 2022-24, these symptoms would be expected to affect a proportion of the population and may plausibly contribute to increased healthcare-seeking. Thus, it is likely that PASC has contributed to the observed increases.

There is also evidence that people with pre-existing neurological conditions can experience exacerbations after COVID-19 (75) and therefore seek contact with their general practitioner. In this context, the rise in ADHD diagnoses among children in Norway since 2021/2022 (76) may increase the number of individuals who are vulnerable to post-infectious symptom exacerbation and thus more likely to seek follow-up care.

This interpretation is further supported by researchers at the Norwegian Labour and Welfare Administration, who have attributed the increase in medically certified sick leave for hyperkinetic disorder to post-acute sequelae of COVID-19 (77).

Comparison with influenza patterns

COVID-19 is frequently compared to influenza. Neither during the influenza (H1N1) pandemic in 2009–2010, nor the period after, did we observe large increases in A04, P29, P02, P03, P81, or P20 as we have in 2022–2024.

Gastrointestinal complaints

Studies report gastrointestinal complaints such as nausea and abdominal pain as symptoms associated with post-acute sequelae of COVID-19 (78). The aforementioned systematic review of 50 controlled studies found in non-hospitalized participants a relative risk of 1.44 (95% CI: 1.11 to 1.86) for abdominal pain, 1.47 (95% CI: 1.30 to 1.66) for vomiting/nausea, and 1.31 (95% CI: 1.22 to 1.42) for diarrhea after COVID-19 (54). Several studies find altered gut microbiome (79) and disruption of the gastrointestinal barrier in fatigued patients with PASC (80). A small internal investigation was launched inside NIPH to look for pathogenic causes behind the increase, but no similar reported increase was found in typical infectious disease pathogens that cause gastroenteritis (22). A previous study by the Norwegian Labour and Welfare Administration found that people with medically certified sick leave due to COVID-19 were 176% more likely to be on sick leave for D73 (gastroenteritis, presumed infectious) in the following 12 weeks than people with medically certified sick leave for not COVID-19 (16).

Children and adolescents

Post-acute sequelae of COVID-19 are common in children and adolescents (81). A recent Norwegian study of 1500 children aged 11–12 years old found a higher incidence of new fatigue and brain fog 3–5 months after Omicron infection compared with uninfected subjects (16). In this study, we observed excesses in fatigue, memory disturbance, hyperkinetic disorder (ADHD/ADD-like symptoms), psychological complaints, and gastrointestinal complaints for children and adolescents. However, how these symptoms affect everyday life remains poorly understood.

The largest relative increase in consultations for memory disturbance occurred among 5–14 year olds, with substantial excesses also observed in the 15–19 and 20–29 year age groups. Girls and young women were disproportionately affected. These age groups correspond to students in primary, secondary, and higher education—populations for whom sustained cognitive function is essential.

Memory disturbances—such as difficulty concentrating, retaining new information, or recalling previously learned material—may impair academic performance. These findings raise concern about the potential long-term academic consequences of repeated SARS-CoV-2 infections. Notably, mathematics competency among Norwegian schoolchildren declined year-on-year from 2022 to 2024 (82). While causality cannot be established from these ecological trends alone, the alignment between rising cognitive complaints in clinical records and declining academic performance warrants further investigation.

Although increased screen time has previously been proposed as a contributing factor to rising cognitive issues in youth (83), national data show that screen use rose steadily from 2014 to 2021, but has since plateaued or declined (70). Since the sharpest increases in memory-related consultations occurred after 2021, screen time trends are unlikely to fully explain the patterns observed here.

Children and adolescents were also disproportionately affected by respiratory infections and other infectious diseases in 2024. Unlike countries such as Australia, Canada, and Germany, Norway has not invested in any form of improved ventilation or air purification in schools to reduce the transmission of SARS-CoV-2 and other airborne pathogens (84). Fewer than 10% of 11–12-year olds in Norway have received a COVID-19 vaccine, and the official evidence base for the national vaccination strategy does not mention PASC in children (85). Nor are annual COVID-19 boosters recommended for children and adolescents in Norway (86,87), despite growing evidence that COVID-19 vaccination reduces the risk of PASC in pediatric populations (88–90) and the frequency of acute infections more broadly (90). Our results indicate that Norwegian children and young people may experience significant excess morbidity as a result of the lack of vaccine recommendations.

Increase in healthcare availability

When considering the expected trend from 2010–2019 of the total number of consultations, the observed number of consultations in 2024 was 3.0% (90% PI: 0.7% to 5.7%) higher than expected.

For many of the ICPC-2 codes discussed in this study, their increases were substantially higher than this overall trend, with many conditions showing increases exceeding 50% above expected levels. This suggests that the observed increases in fatigue and neuropsychiatric conditions cannot be attributed solely to general increases in healthcare utilization or expanded access to primary care services. The magnitude of increase for specific conditions—particularly weakness/tiredness general

(63% excess), memory disturbance (59% excess), and hyperkinetic disorder (105% excess)—far exceeds what would be expected from a modest overall increase in consultation volume.

Additionally, the temporal correlations between these specific conditions and COVID-19 community spread further support the hypothesis that these increases represent genuine health impacts that at least partially can be ascribed to PASC, rather than healthcare system changes or increased general practitioner availability.

The role of e-consultations

For the purposes of this study, both physical consultations and e-consultations were treated equally. Our previous study found that the mean annual number of consultations per general practitioner in 2023 had returned to the pre-pandemic norms, indicating that e-consultations are not artificially increasing the number of consultations (22).

While we had reliable data on e-consultations in the daytime from 2020 to 2024, we only had reliable data for nighttime e-consultations from 2020 to 2022 (Additional file 3). For this reason, we excluded the nighttime e-consultations from the analysis dataset. For the ICPC-2 codes A04, P02, P20, P29, and P81, we found that daytime e-consultations peaked in 2021, with a year-on-year decline until 2024. We found that in 2022, approximately 5% of these ICPC-2 codes were assigned from nighttime e-consultations. This implies that we likely have an underestimation of the true excesses by around 5%, which means our reported increases of 63% for weakness/tiredness general, 59% for memory disturbance, 106% for hyperkinetic disorder, 79% for psychological symptom/complaint other, and 68% for acute stress reaction may be conservative estimates. The exclusion of nighttime e-consultations therefore strengthens rather than weakens our findings.

Comparison with previous study

Our results are largely consistent with our previous study that compared medically certified sick leave and primary healthcare consultations in 2023 with the pre-pandemic 2010–2019 trends (22).

This study expands upon the previous study by revealing that the situation in 2024 is worse than in 2023 and also affects children and adolescents. This development is troubling, given that a large proportion of Norwegian children have experienced repeated SARS-CoV-2 infections since 2022.

Comparisons with other countries

Similar trends to what we report here have been observed internationally. In most European countries, sick leave in 2023 was higher than in 2019, regardless of specific cause (91). In Spain, the proportion of adults reporting chronic health problems increased from a stable 30% (2012–2019) to 42% in early 2022, and reached 50% in late 2024 (92–95). In the United States, the number of people aged 16 and over living with a disability remained steady at 29–31 million until 2019, before rising continuously from mid-2020 to nearly 35 million by the end of 2024 (96). These parallel trends strengthen the case that Norway's rise in consultations reflects real shifts in population health, rather than isolated measurement bias or national reporting artefacts, and that these shifts are related to the COVID-19 pandemic.

Implication for the future burden on primary healthcare

It is likely that the increases in primary healthcare consultations for fatigue, memory disturbance, hyperkinetic disorder (ADHD/ADD-like symptoms), psychological complaints, and gastrointestinal complaints are at least partially related to post-acute effects from COVID-19.

Longitudinal studies suggest poor recovery for many individuals affected by PASC. A Norwegian study reported that the (elevated) risk of executive deficits more than 366 days after SARS-CoV-2 infection were not significantly different to the (elevated) risk 91–182 days after SARS-CoV-2 infection; that is, recovery was limited (74). Another Norwegian study reported that only 8% of patients receiving “care as usual” at a post-COVID-clinic recovered after 12 months (97). A Danish study reported that more than 50% of patients at a post-COVID clinic showed no improvement after 1.5 years (98).

SARS-CoV-2 infection is associated with a nearly 400% increase in risk of ME/CFS (56); for this patient population, few show benefit of return-to-health/work interventions (99).

Of the 17,170,953 primary healthcare consultations recorded in Norway in 2024 across all conditions, excess consultations for fatigue, memory disturbance, hyperkinetic disorder (ADHD/ADD-like symptoms), psychological complaints, and gastrointestinal complaints accounted for approximately 733,000—equivalent to 4.3% of the total. Thus, the extra burden on healthcare systems is substantial. If SARS-CoV-2 infections continue to be as prevalent, it should be expected that an excess burden will persist in the coming years.

Limitations

The fundamental limitation of this study is that it is a study based on aggregate data analyzing temporal changes. While these condition-specific findings are suggestive, the aggregate and ecological nature of the data necessitates caution in causal attribution.

The design also does not allow us to control for contributions from other factors associated with the SARS-CoV-2 pandemic that may have contributed to the increase in healthcare demand, such as depression triggered by preventative measures, loss of activities related to private or business life, loss of loved ones as reflected in the observed excess mortality, etc. The results must therefore be interpreted in relation to data and results from other studies.

A further limitation of this study is the inability to capture the full extent of SARS-CoV-2 spread due to the lack of reliable community transmission data. Nevertheless, our proxy measure based on vaccine efficacy and hospitalization rates provided valuable insights, showing positive temporal correlations with a range of health conditions.

An additional limitation of this study is that only 101 ICPC-2 code combinations were available from NorSySS.

Strengths

This study has several notable strengths. First, it utilizes national-level registry data from the Norwegian Syndromic Surveillance System (NorSySS), ensuring near-complete coverage of primary healthcare consultations across Norway. NorSySS captures both general practitioner and out-of-hours consultations, regardless of whether they occur physically or digitally, providing a comprehensive view of healthcare utilization patterns.

Second, the analyses were stratified by age and sex, enabling detailed assessments across demographic strata. This level of granularity revealed important findings, such as differential impacts among children, adolescents, and adults, and between sexes for certain conditions.

Third, the study complements and expands upon previously published work by the authors, allowing for year-over-year comparison and establishing that several concerning trends in 2023 have not only persisted but worsened in 2024.

Finally, the study incorporated a proxy for COVID-19 community spread, allowing for the exploration of temporal correlations between COVID-19 community spread and healthcare utilization.

Together, these strengths lend confidence to the conclusion that the observed increases in healthcare utilization for several conditions are not random fluctuations, but are likely associated with systemic effects stemming from COVID-19, likely exacerbated by the Norwegian public health response since 2022.

Conclusions

Substantial increases were observed in primary healthcare consultations in 2024 compared to pre-pandemic levels. Many of the conditions with the greatest excess are associated with post-acute COVID-19 sequelae. The findings suggest ongoing population-level health impacts associated with repeated SARS-CoV-2 infections, particularly among women, children, adolescents, and young adults. Evidence from this study suggests that children in Norway experience excess morbidity related to a lack of protection from SARS-CoV-2 vaccines. Given that Norway's COVID-19 strategy and risk assessments do not address PASC, this information provides critical evidence for understanding the population health consequences of policies that encourage repeated SARS-CoV-2 infections. The results from this and our previous study suggest that inaction in the face of these signals may institutionalize chronic illness within the population, with far-reaching consequences for workforce participation, healthcare capacity, and national economic stability.

List of abbreviations

COVID-19: Coronavirus disease 2019.

FDR: False discovery rate.

ICPC-2: International Classification of Primary Care version 2.

KPR: Municipal Patient and User Register; Norwegian: Kommunalt pasient- og brukerregister.

KUHR: Control and Payment of Health Reimbursements; Norwegian: Kontroll og utbetaling av helserefusjoner.

NIPH: Norwegian Institute of Public Health; Norwegian: Folkehelseinstituttet.

NorSySS: Norwegian Syndromic Surveillance System; Norwegian: Det norske syndromiske overvåkingssystemet.

PCR: Polymerase chain reaction.

PI: Prediction interval.

RNA: Ribonucleic acid.

SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2.

Declarations

Ethics approval and consent to participate

Not applicable. All data are aggregate registry data.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the Norwegian Syndromic Surveillance System, which were used under license for the current study, and so are not publicly available. Applications for data may be made to the Norwegian Syndromic Surveillance System.

Competing interests

RAW and BVS are employed by the Norwegian Institute of Public Health, which is responsible for providing guidance and recommendations regarding COVID-19 in Norway. The other authors declare that they have no competing interests.

Funding

The Norwegian state employees (RAW, BVS) performed this work as a part of their daily tasks and are funded by the Norwegian state. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of their employers.

Author's contributions

RAW and BVS acquired the data. RAW performed the analysis. All authors contributed to the writing and editing of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

Table 1. Number of primary healthcare consultations for COVID-19 (R992+R991) per year.

Figure 1. Total number of primary healthcare consultations per year from 2010–2024, with an expected baseline calculated using data from 2010–2019.

Figure 2. Different measures of COVID-19 community spread between 2020-W09 and 2024-W52.

Figure 3. Ratio of 2024 incidence against 2010–2019 baseline and correlation within COVID-19 community spread for ICPC-2 codes A*, B*, D*, F*, H*, N*, P*.

Figure 4. Ratio of 2024 incidence against 2010–2019 baseline and correlation within COVID-19 community spread for ICPC-2 codes R*, S*, U*, X*, Y*.

Figure 5. Number of primary healthcare consultations per year from 2006–2024 for the 10 ICPC-2 code combinations with largest excess in 2024 when compared against the 2010–2019 baseline.

Additional File 1. Estimates for 101 ICPC-2 code combinations and all sex and age combinations.

Additional File 2. Trend graphs and residual diagnostic plots for the results in Additional File 1.

Additional File 3. Proportion of primary healthcare consultations for A04, P02, P20, P29, and P81 per year from 2019–2024 that are registered as physical consultations (day/night) or electronic consultations (day/night).

References

1. Peluso MJ, Deeks SG. Mechanisms of long COVID and the path toward therapeutics. Cell. 2024 Oct 3;187(20):5500–29.

2. Ford ND. Long COVID and Significant Activity Limitation Among Adults, by Age — United States, June 1–13, 2022, to June 7–19, 2023. MMWR Morb Mortal Wkly Rep [Internet]. 2023 [cited 2025 June 2];72. Available from: https://www.cdc.gov/mmwr/volumes/72/wr/mm7232a3.htm

3. Bartsch SM, Chin KL, Strych U, John DC, Shah TD, Bottazzi ME, et al. The Current and Future Burden of Long COVID in the United States. J Infect Dis. 2025 Jan 22;jiaf030.

4. Altmann DM, Whettlock EM, Liu S, Arachchillage DJ, Boyton RJ. The immunology of long COVID. Nat Rev Immunol. 2023 Oct;23(10):618–34.

5. Al-Aly Z, Davis H, McCorkell L, Soares L, Wulf-Hanson S, Iwasaki A, et al. Long COVID science, research and policy. Nat Med. 2024 Aug;30(8):2148–64.

6. Costantino V, Grafton Q, Kompas T, Chu L, Honeyman D, Notaras A, et al. The public health and economic burden of long COVID in Australia, 2022–24: a modelling study. Med J Aust. 2024 Aug 19;221(4):217–23.

7. Kwon J, Mensah J, Milne R, Rayner C, Lawrence RR, De Kock J, et al. Health economic outcomes and national economic impacts associated with Long COVID in England and Scotland. Eur J Health Econ [Internet]. 2025 July 9 [cited 2025 July 11]; Available from: https://doi.org/10.1007/s10198-025-01788-1

8. Helse og omsorgsdepartementet. Regjeringen.no. regjeringen.no; 2023 [cited 2025 Mar 27]. Regjeringens strategi og beredskapsplan for håndteringen av covid-19-pandemien. Available from: https://www.regjeringen.no/no/dokumentarkiv/regjeringen-stoere/andre-dokumenter/hod/2023/regjeringens-strategi-og-beredskapsplan-for-handteringen-av-covid-19-pandemien/id2987438/

9. World Health Organization. Clinical management of COVID-19: living guideline, 18 August 2023. World Health Organization; 2023 p. 186 p.

10. Norwegian Institute of Public Health. Epidemier av luftveisinfeksjoner i Norge vinteren 2023-24: risiko, scenarioer og håndtering. Norwegian Institute of Public Health Oslo; 2023.

11. New-onset, self-reported long COVID after coronavirus (COVID-19) reinfection in the UK - Office for National Statistics [Internet]. [cited 2025 May 27]. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/newonsetselfreportedlongcovidaftercoronaviruscovid19reinfectionintheuk/23february2023

12. Bowe B, Xie Y, Al-Aly Z. Acute and postacute sequelae associated with SARS-CoV-2 reinfection. Nat Med. 2022 Nov;28(11):2398–405.

13. Government of Canada SC. Experiences of Canadians with long-term symptoms following

COVID-19 [Internet]. 2023 [cited 2025 May 27]. Available from: https://www150.statcan.gc.ca/n1/pub/75-006-x/2023001/article/00015-eng.htm

14. Todal PA. Med smitte skal landet vernast [Internet]. 2024 [cited 2025 Mar 27]. Available from: https://www.dagogtid.no/samfunn/med-smitte-skal-landet-vernast/143147

15. Greenhalgh T, Sivan M, Perlowski A, Nikolich JŽ. Long COVID: a clinical update. The Lancet. 2024 Aug;404(10453):707–24.

16. Caspersen IH, Skodvin SN, Blix K, Robertson AH, Laake I, Feiring B, et al. Post-COVID symptoms after SARS-CoV-2 omicron infection and the effect of booster vaccination: A population-based cohort study. Vaccine. 2025 Feb 15;47:126664.

17. Xie Y, Choi T, Al-Aly Z. Postacute Sequelae of SARS-CoV-2 Infection in the Pre-Delta, Delta, and Omicron Eras. N Engl J Med. 2024 Aug 8;391(6):515–25.

18. Spiliopoulos L, Sørensen AIV, Bager P, Nielsen NM, Hansen JV, Koch A, et al. Postacute symptoms 4 months after SARS-CoV-2 infection during the Omicron period: a nationwide Danish questionnaire study. Am J Epidemiol. 2024 Aug 5;193(8):1106–14.

19. International Classification of Primary Care, 2nd edition (ICPC-2) [Internet]. [cited 2025 June 2]. Available from: https://www.who.int/standards/classifications/other-classifications/international-classification-of-primary-care

20. Okkes I, Jamoulle M, Lamberts H, N Bentzen. ICPC-2-E: the electronic version of ICPC-2. Differences from the printed version and the consequences. Fam Pract. 2000 Apr 1;17(2):101–7.

21. Helsedirektoratet [Internet]. [cited 2025 June 2]. Koderettleiing ved covid-19. Available from: https://www.helsedirektoratet.no/digitalisering-og-e-helse/helsefaglige-kodeverk/icpc/koderettleiing-ved-covid-19

22. White RA, Zhang C, Valcarcel Salamanca B, Angelsen A, Zakiudin DP, Andries A, et al. Aberrations in medically certified sick leave and primary healthcare consultations in Norway in 2023 compared to pre-COVID-19-pandemic trends. Arch Public Health. 2024 Oct 22;82(1):187.

23. World Health Organization. Ending the COVID-19 emergency and transitioning from emergency phase to longer-term disease management: Guidance on calibrating the response [Internet]. 2023 [cited 2025 July 21]. Available from: https://iris.who.int/bitstream/handle/10665/372712/WHO-WHE-SPP-2023.2-eng.pdf?sequence=1

24. Swanson D, Koren C, Hopp P, Jonsson ME, Rø GI, White RA, et al. A One Health real-time surveillance system for nowcasting Campylobacter gastrointestinal illness outbreaks, Norway, week 30 2010 to week 11 2022. Euro Surveill Bull Eur Sur Mal Transm Eur Commun Dis Bull. 2022 Oct;27(43):2101121.

25. Bürkner PC. brms: An R Package for Bayesian Multilevel Models Using Stan. J Stat Softw. 2017;80(1):1–28.

26. Bürkner PC. Advanced Bayesian Multilevel Modeling with the R Package brms. R J. 2018;10(1):395–411.

27. Bürkner PC. Bayesian Item Response Modeling in R with brms and Stan. J Stat Softw. 2021;100(5):1–54.

28. R Core Team. R: A Language and Environment for Statistical Computing [Internet]. Vienna, Austria: R Foundation for Statistical Computing; 2024. Available from: https://www.R-project.org/

29. White RA. org: Organising Projects [Internet]. 2019 [cited 2025 July 3]. p. 2024.6.5. Available from: https://CRAN.R-project.org/package=org

30. White RA. plnr: A System for Planing Analyses [Internet]. 2022 [cited 2025 July 3]. p. 2022.11.23. Available from: https://CRAN.R-project.org/package=plnr

31. Vogt H. Medier og forskere maler fanden på veggen om «langvarig covid-19» og kronisk utmattelse [Internet]. 2020 [cited 2025 July 2]. Available from: https://www.aftenposten.no/meninger/kronikk/i/opdB6a/en-fryktdrevet-pandemi-av-varige-helseproblemer

32. Vogt H. En fryktdrevet pandemi av varige helseproblemer [Internet]. Infectious disease conference for specialist- and municipal health authorities; 2020 Oct 13; Norwegian Institute of Public Health. Available from: https://www.fhi.no/contentassets/cdc14afe910149d28af3d93be55765c9/program-smitteverndager-webinar.pdf

33. Olaisen SR. NRK. 2022 [cited 2025 July 2]. Legar seier korona kan vare kortare om ein ikkje er redd: – Kjipt å høyre. Available from: https://www.nrk.no/nordland/frykt-for-korona-forlenger-forlopet_-meiner-lege.-kognitive-teknikkar-kan-vere-ei-loysing-1.15837918

34. Alme TN, Andreasson A, Asprusten TT, Bakken AK, Beadsworth MB, Boye B, et al. Chronic fatigue syndromes: real illnesses that people can recover from. Scand J Prim Health Care. 2023 Oct 2;41(4):372–6.

35. Wessely S, David A, Butler S, Chalder T. Management of chronic (post-viral) fatigue syndrome. J R Coll Gen Pract. 1989 Jan;39(318):26–9.

36. Surawy C, Hackmann A, Hawton K, Sharpe M. Chronic fatigue syndrome: a cognitive approach. Behav Res Ther. 1995 June;33(5):535–44.

37. Vink M, Vink-Niese A. Decade old approach, relabelled as a new one by the Oslo Chronic Fatigue Consortium, is harmful and does not lead to objective improvement in ME/CFS or long Covid [Internet]. Center for Open Science; 2024 [cited 2025 July 18]. Available from: https://osf.io/xe82n

38. Ruf W. Immune damage in Long Covid. Science. 2024 Jan 19;383(6680):262–3.

39. Files JK, Boppana S, Perez MD, Sarkar S, Lowman KE, Qin K, et al. Sustained cellular immune dysregulation in individuals recovering from SARS-CoV-2 infection. J Clin Invest [Internet]. 2021 Jan 4 [cited 2025 July 3];131(1). Available from: https://www.jci.org/articles/view/140491

40. André S, Picard M, Cezar R, Roux-Dalvai F, Alleaume-Butaux A, Soundaramourty C, et al. T cell apoptosis characterizes severe Covid-19 disease. Cell Death Differ. 2022 Aug;29(8):1486–99.

41. Jing Y, Luo L, Chen Y, Westerberg LS, Zhou P, Xu Z, et al. SARS-CoV-2 infection causes immunodeficiency in recovered patients by downregulating CD19 expression in B cells via enhancing B-cell metabolism. Signal Transduct Target Ther. 2021 Sept 22;6(1):345.

42. Cai M, Xu E, Xie Y, Al-Aly Z. Rates of infection with other pathogens after a positive COVID-19 test versus a negative test in US veterans (November, 2021, to December, 2023): a retrospective cohort study. Lancet Infect Dis. 2025 Apr;S1473309924008314.

43. Rubin R. From "Immunity Debt" to "Immunity Theft"-How COVID-19 Might Be Tied to Recent Respiratory Disease Surges. JAMA. 2024 Feb 6;331(5):378–81.

44. Wang L, Davis PB, Berger N, Kaelber DC, Volkow N, Xu R. Association of COVID-19 with respiratory syncytial virus (RSV) infections in children aged 0-5 years in the USA in 2022: a multicentre retrospective cohort study. Fam Med Community Health. 2023 Oct;11(4):e002456.

45. Kumwichar P, Chongsuvivatwong V. COVID-19 pneumonia and the subsequent risk of getting active pulmonary tuberculosis: a population-based dynamic cohort study using national insurance claims databases. EClinicalMedicine. 2023 Feb;56:101825.

46. Mizrahi B, Sudry T, Flaks-Manov N, Yehezkelli Y, Kalkstein N, Akiva P, et al. Long covid outcomes at one year after mild SARS-CoV-2 infection: nationwide cohort study. BMJ. 2023 Jan 11;380:e072529.

47. Salamanca BV, Cyr PR, Bentdal YE, Watle SV, Wester AL, Strand ÅMW, et al. Increase in invasive group A streptococcal infections (iGAS) in children and older adults, Norway, 2022 to 2024. Eurosurveillance. 2024 May 16;29(20):2400242.

48. Mahesh T, Changela S, Duong KS, Henry S, Wang SH, Duong TQ. New-onset conjunctivitis 3.5 years post SARS-CoV-2 infection in an inner-city population in the Bronx. BMJ Open Ophthalmol [Internet]. 2025 May 22 [cited 2025 July 2];10(1). Available from: https://bmjophth.bmj.com/content/10/1/e001993

49. Hollborn H, Lachmann C, Strüder D, van Bonn SM, Mlynski R, Schraven SP. Rise in complications of acute otitis media during and after the COVID-19 pandemic. Eur Arch Oto-Rhino-Laryngol Off J Eur Fed Oto-Rhino-Laryngol Soc EUFOS Affil Ger Soc Oto-Rhino-Laryngol - Head Neck Surg. 2024 Sept;281(9):4627–33.

50. Raad N, Ghorbani J, Mikaniki N, Haseli S, Karimi-Galougahi M. Otitis media in coronavirus disease 2019: a case series. J Laryngol Otol. 2021 Jan;135(1):10–3.

51. Mohan S, Workman A, Barshak M, Welling DB, Abdul-Aziz D. Considerations in Management of Acute Otitis Media in the COVID-19 Era. Ann Otol Rhinol Laryngol. 2021 May;130(5):520–7.

52. Fidan V. New type of corona virus induced acute otitis media in adult. Am J Otolaryngol. 2020;41(3):102487.

53. Bowe B, Xie Y, Al-Aly Z. Postacute sequelae of COVID-19 at 2 years. Nat Med. 2023 Sept;29(9):2347–57.

54. O'Mahoney LL, Routen A, Gillies C, Jenkins SA, Almaqhawi A, Ayoubkhani D, et al. The risk of Long Covid symptoms: a systematic review and meta-analysis of controlled studies. Nat Commun. 2025 May 7;16(1):4249.

55. Magnusson K, Kristoffersen DT, Dell'Isola A, Kiadaliri A, Turkiewicz A, Runhaar J, et al. Post-covid medical complaints following infection with SARS-CoV-2 Omicron vs Delta variants. Nat Commun. 2022 Nov 30;13(1):7363.

56. Vernon SD, Zheng T, Do H, Marconi VC, Jason LA, Singer NG, et al. Incidence and Prevalence of Post-COVID-19 Myalgic Encephalomyelitis: A Report from the Observational RECOVER-Adult Study. J Gen Intern Med. 2025 Apr 1;40(5):1085–94.

57. Jan Lippestad, Nanna Kurtze, Anne Mette Bjerkan. Status for helse- og omsorgstilbudet til pasienter med CFS/ME i Norge [Internet]. SINTEF; 2011 Jan. Available from: https://www.sintef.no/publikasjoner/publikasjon/1268102/

58. Moberg LL, Kabash S. Sykefravær etter covid-19. Arb Og Velferd. 2023(2):25–40.

59. Helsedirektoratet [Internet]. [cited 2025 May 27]. Utbrenthet (P29 Psykiske symptomer/plager). Available from: https://www.helsedirektoratet.no/veiledere/sykmelderveileder/diagnosespesifikke-anbefalinger-for-sykmelding/psykisk-p/utbrenthet-p29-psykiske-symptomerplager

60. Helsedirektoratet. FinnKode - P29 [Internet]. [cited 2025 May 27]. Available from: https://finnkode.helsedirektoratet.no/icpc2/chapter/P29?q=slitenhet

61. Helsedirektoratet. FinnKode - P02 [Internet]. [cited 2025 May 27]. Available from: https://finnkode.helsedirektoratet.no/icpc2/chapter/P02?q=p02

62. Taquet M, Sillett R, Zhu L, Mendel J, Camplisson I, Dercon Q, et al. Neurological and psychiatric risk trajectories after SARS-CoV-2 infection: an analysis of 2-year retrospective cohort studies including 1 284 437 patients. Lancet Psychiatry. 2022 Oct;9(10):815–27.

63. Taquet M, Geddes JR, Husain M, Luciano S, Harrison PJ. 6-month neurological and psychiatric outcomes in 236 379 survivors of COVID-19: a retrospective cohort study using electronic health records. Lancet Psychiatry. 2021 May 1;8(5):416–27.

64. Xie Y, Xu E, Al-Aly Z. Risks of mental health outcomes in people with covid-19: cohort study. 2022 Feb 16 [cited 2025 July 2]; Available from: https://www.bmj.com/content/376/bmj-2021-068993.abstract

65. Jaiswal S, Sahoo S, Dhiman V, Sachdeva N, Singh MP, Ram S, et al. Long COVID psychiatric sequelae, biochemical markers & tau protein: A 3-year follow-up study. Psychiatry Res. 2025 May 1;347:116413.

66. Vasiliadis HM, Campello CP, Tanguay-Labrèche M, Lamoureux-Lamarche C, Berbiche D. Post-COVID onset of psychiatric complications and associated COVID-related symptom impairment and organ system complications over 24 months. Psychiatry Res. 2025 Sept 1;351:116571.

67. Moen JK, Baker CA, Iwasaki A. Neuroimmune pathophysiology of long COVID. Psychiatry Clin Neurosci [Internet]. [cited 2025 July 15];n/a(n/a). Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/pcn.13855

68. Ellingjord-Dale M, Brunvoll SH, Søraas A. Prospective Memory Assessment before and after Covid-19. N Engl J Med. 2024 Feb 28;390(9):863–5.

69. Liu H, Chen X, Huang M, Yu X, Gan Y, Wang J, et al. Screen time and childhood attention deficit hyperactivity disorder: a meta-analysis. Rev Environ Health. 2024 Dec 17;39(4):643–50.

70. Bakken A. Ungdata 2024. Nasjonale resultater [Internet]. 68. NOVA/OsloMet; 2024 [cited 2025 July 15]. Available from: https://oda.oslomet.no/oda-xmlui/handle/11250/3145138

71. Shkalim Zemer V, Manor I, Weizman A, Cohen HA, Hoshen M, Menkes Caspi N, et al. The influence of COVID-19 on attention-deficit/hyperactivity disorder diagnosis and treatment rates across age, gender, and socioeconomic status: A 20-year national cohort study. Psychiatry Res. 2024 Sept 1;339:116077.

72. Auro K, Holopainen I, Perola M, Havulinna AS, Raevuori A. Attention-Deficit/Hyperactivity Disorder Diagnoses in Finland During the COVID-19 Pandemic. JAMA Netw Open. 2024 June 27;7(6):e2418204.

73. Charles James J, Schulze H, Siems N, Prehn C, Quast DR, Trampe N, et al. Neurological post-COVID syndrome is associated with substantial impairment of verbal short-term and working memory. Sci Rep. 2025 Jan 11;15(1):1695.

74. Buer S, Hagen BI, Søraas A, White RA, Bø R, Ellingjord-Dale M, et al. Executive deficits after SARS-CoV-2 infection: A cross-sectional population study. Brain Behav Immun - Health. 2024 Nov;41:100857.

75. Hadidchi R, Al-Ani Y, Choi S, Renteria S, Duong KS, Henry S, et al. Long-term outcomes of patients with a pre-existing neurological condition after SARS-CoV-2 infection. J Neurol Sci [Internet]. 2025 June 15 [cited 2025 July 2];473. Available from: https://www.jns-journal.com/article/S0022-510X(25)00094-2/abstract

76. Folkehelseinstituttet [Internet]. 2024 [cited 2025 July 17]. Psykiske plager og lidelser hos barn og unge. Available from: https://www.fhi.no/he/fr/folkehelserapporten/psykisk-helse/psykisk-helse-hos-barn-og-unge/

77. Nossen JP, Delalic L. Hvorfor er sykefraværet fortsatt høyt 3–4 år etter starten av pandemien? | Arbeid og velferd. Arb Og Velferd [Internet]. [cited 2025 May 22];2024(2). Available from: https://arbeidogvelferd.nav.no/article/2024/06/Hvorfor-er-sykefraværet-fortsatt-høyt-3–4-år-etter-starten-av-pandemien

78. Davis HE, McCorkell L, Vogel JM, Topol EJ. Long COVID: major findings, mechanisms and recommendations. Nat Rev Microbiol. 2023 Mar;21(3):133–46.

79. Lee KH, Kim YO, Dho SH, Yong JJH, Oh HS, Lee JH, et al. Altered gut microbiome in convalescent patients with coronavirus disease 2019. Front Cell Infect Microbiol [Internet]. 2024 Nov 28 [cited 2025 July 3];14. Available from: https://www.frontiersin.org/journals/cellular-and-infection-microbiology/articles/10.3389/fcimb.2024.1455295/full

80. Rohrhofer J, Wolflehner V, Schweighardt J, Koidl L, Stingl M, Zehetmayer S, et al. Gastrointestinal Barrier Disruption in Post-COVID Syndrome Fatigue Patients. Allergy [Internet]. [cited 2025 July 3];(n/a). Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/all.16593

81. Rao S, Gross RS, Mohandas S, Stein CR, Case A, Dreyer B, et al. Postacute Sequelae of SARS-CoV-2 in Children. Pediatrics. 2024 Mar 1;153(3):e2023062570.

82. Utdanningsdirektoratet. Klar nedgang i regneferdighetene [Internet]. [cited 2025 May 23]. Available from: https://www.udir.no/tall-og-forskning/statistikk/statistikk-grunnskole/analyser/2024/resultater-fra-nasjonale-prover-for-ungdomstrinnet-2024/

83. Wilthil JE. NRK. 2025 [cited 2025 July 15]. Eksplosiv økning: Barn sliter med hukommelsen. Available from: https://www.nrk.no/buskerud/eksplosiv-okning_-barn-sliter-med-hukommelsen-1.17448953

84. Jelstad J. Forskere krever bedre inneklima i skoler: FHI: – Mangler kunnskap om effekten av god ventilasjon [Internet]. 2022 [cited 2025 May 23]. Available from: https://www.utdanningsnytt.no/fhi-forfall-forskning/forskere-krever-bedre-inneklima-i-skoler-fhi-mangler-kunnskap-om-effekten-av-god-ventilasjon/335272

85. Folkehelseinstituttet. Svar på oppdrag B1 i foreløpig tildelingsbrev - Forslag til målgrupper for koronavaksinasjonsprogrammet i 2024 [Internet]. 2024 [cited 2025 July 15]. Available from: https://www.fhi.no/contentassets/1af4c6e655014a738055c79b72396de8/svar-pa-oppdrag-b1-i-forelopig-tildelingsbrev---forslag-til-malgrupper-for-koronavaksinasjonsprogrammet-i-2024_sladdet.pdf

86. Folkehelseinstituttet [Internet]. 2024 [cited 2025 May 22]. Koronavaksine - Vaksineanbefalinger for sesong 2024/2025. Available from: https://www.fhi.no/ss/korona/koronavaksinasjonsprogrammet/koronavaksine/

87. Helse-og omsorgsdepartementet. Regjeringen.no. regjeringen.no; 2022 [cited 2025 May 23]. Koronavaksinasjon av barn og unge. Available from: https://www.regjeringen.no/no/aktuelt/koronavaksinasjon-av-barn-og-unge/id2895513/

88. Yousaf AR, Mak J, Gwynn L, Lutrick K, Bloodworth RF, Rai RP, et al. COVID-19 Vaccination and Odds of Post–COVID-19 Condition Symptoms in Children Aged 5 to 17 Years. JAMA Netw Open. 2025 Feb 24;8(2):e2459672.

89. Hedberg P, van der Werff SD, Nauclér P. The Effect of COVID-19 Vaccination on the Risk of Persistent Post–COVID-19 Condition: Cohort Study. J Infect Dis. 2025 May 15;231(5):e941–4.

90. Höppner J, Maier C, Schlegtendal A, Hoffmann A, Petersmann A, Lücke T, et al. Long-term effects of SARS-CoV-2 infection and vaccination in a population-based pediatric cohort. Sci Rep. 2025 Jan 23;15(1):2921.

91. White RA. Debatten om sykefravær er ført på feil premisser [Internet]. 2025 [cited 2025 June 2]. Available from: https://frifagbevegelse.no/debatt/debatten-om-sykefravar-er-fort-pa-feil-premisser-6.490.1106983.a33706873a

92. Centro de Investigaciones Sociológicas. CIS. [cited 2025 June 2]. Estudio: 3470 - BARÓMETRO SANITARIO 2024 (SEGUNDA OLEADA). Available from: https://www.cis.es/detalle-ficha-estudio?origen=estudio&idEstudio=14838

93. Centro de Investigaciones Sociológicas. CIS. [cited 2025 June 2]. Estudio: 3357 - BARÓMETRO SANITARIO 2022 (PRIMERA OLEADA). Available from: https://www.cis.es/detalle-ficha-estudio?origen=estudio&idEstudio=14619

94. Centro de Investigaciones Sociológicas. CIS. [cited 2025 June 2]. Estudio: 3266 - BARÓMETRO SANITARIO 2019 (TERCERA OLEADA). Available from: https://www.cis.es/detalle-ficha-

estudio?origen=estudio&idEstudio=14477

95. Centro de Investigaciones Sociológicas. CIS. [cited 2025 June 2]. Estudio: 2946 - BARÓMETRO SANITARIO 2012 (SEGUNDA OLEADA). Available from: https://www.cis.es/detalle-ficha-estudio?origen=estudio&idEstudio=14085

96. Federal Reserve Bank of St. Louis. Population - With a Disability, 16 Years and over [Internet]. 2025 [cited 2025 June 2]. Available from: https://fred.stlouisfed.org/series/LNU00074597

97. Nerli TF, Selvakumar J, Cvejic E, Heier I, Pedersen M, Johnsen TL, et al. Brief Outpatient Rehabilitation Program for Post-COVID-19 Condition: A Randomized Clinical Trial. JAMA Netw Open. 2024 Dec 2;7(12):e2450744.

98. Agergaard J, Gunst JD, Schiøttz-Christensen B, Østergaard L, Wejse C. Long-term prognosis at 1.5 years after infection with wild-type strain of SARS-CoV-2 and Alpha, Delta, as well as Omicron variants. Int J Infect Dis IJID Off Publ Int Soc Infect Dis. 2023 Dec;137:126–33.

99. Kielland A, Liu J, Jason LA. Do diagnostic criteria for ME matter to patient experience with services and interventions? Key results from an online RDS survey targeting fatigue patients in Norway. J Health Psychol. 2023 Nov;28(13):1189–203.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- ADDITI1.xls
- ADDITI2.xls
- ADDITI1.pdf