# Seroprevalence of SARS-CoV-2 antibodies in a prospective cohort of patients admitted to an acute psychiatric ward in Norway during the initial months of the COVID-19 pandemic

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# Seroprevalence of SARS-CoV-2 antibodies in a prospective cohort of patients admitted to an acute psychiatric ward in Norway during the initial months of the COVID-19 pandemic

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## ABSTRACT

**Background:** The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes coronavirus disease 2019 (COVID-19) spread around the world during the first part of 2020. The purpose of the study was to assess the prevalence of SARS-CoV-2 infection among patients acutely admitted to the Psychiatric Clinic, Haukeland University Hospital.

**Methods:** Serum tests to assess for antibodies to SARS-CoV-2 were administered at admission to the clinic together with a questionnaire on symptoms and demographical information. Further information was obtained from the medical records.

**Results:** The cumulative seroprevalence in the 266 participants was 0.75%, the cumulative reported cases in the Norwegian general population was 0.61% at the end of the inclusion period of the study. Twenty-five percent of participants had risk factors for a serious course of COVID-19. There was a low prevalence of cohabitation and only 20% had their main income derived from ordinary salaries (not welfare).

**Conclusion:** The prevalence of SARS-CoV-2 infection in a sample of patients acutely admitted to the Psychiatric Clinic, Haukeland University Hospital, was comparable to reported cases in the general population. A possible link to governmental and municipal restrictions, general low workplace participation and cohabitation is discussed.

## KEY FINDINGS

- Seroprevalence of SARS-CoV-2 antibodies is comparable to the general population.
- Twenty-five percent of patients had elevated risk for a serious course of COVID-19 because of somatic conditions.
- Fifty-seven percent lived alone, 17% with one other person in the household.
- Twenty percent had regular salary as the main income source for the last three months before admission.

## 1. Background

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes coronavirus disease 2019 (COVID-19) was detected in Wuhan, China in December 2019 and spread around the world during the first part of 2020 [1]. The World Health Organization (WHO) declared SARS-CoV-2 as a pandemic at 11 March 2020 [2]. During the first weeks of March 2020, psychiatric hospitals elevated their measures to prevent the spread of virus after the pandemic was declared. In Norway, a steep rise in the numbers of people infected with the SARS-CoV-2 and hospital admissions due to complicated cases of COVID-19 was experienced in the early weeks of March 2020 (https://www.worldometers.info/coronavirus/country/norway/). The initial surveillance of SARS-CoV-2 focused primarily on patients with severe disease, and the

full spectrum of the disease, including the extent and fraction of mild or asymptomatic infections that did not require medical attention was not clear. In addition, the role of asymptomatic or subclinical infections in human-to-human transmission of SARS-CoV-2 was not understood and it was not yet clear whether those who were reported as asymptomatic could transmit the virus to other individuals [3]. From April 2020, serological analyses suitable for detecting patients who had undergone infection were established at Haukeland University Hospital and it was possible to study the epidemiology of the SARS-CoV-2 in the hospital population. With a novel coronavirus, initial seroprevalence in the population is assumed to be negligible due to the virus being novel in origin. Therefore, surveillance of antibody seropositivity in a population can allow inferences to be made about the extent

of infection and about the cumulative incidence of infection in the population [4].

Patients with severe mental illness (SMI) are expected to have increased mortality rates from COVID-19 based on a higher infection mortality in general [5] and specifically elevated mortality from pulmonary infections [6]. Early findings from Chinese researchers supported this anticipation [7], and increased mortality for patients with schizophrenia was also found in a US cohort of 7348 people with SARS-CoV-2 infection, while this was not the case for the participants with a mood or anxiety disorder [8]. In a study of 144,321 people with a positive test for SARS-CoV-2 in the Danish administrative databases up to 2 January 2021 [9], increased risk for severe COVID-19 disease and death was identified for schizophrenia spectrum disorders, bipolar disorders, unipolar depression and people on psychotropic drugs. A recent meta-analysis with 16 studies and over 19,000 patients with a mental disorder and COVID-19 infection who were included [10] found an adjusted odds ratio of 1.67 for risk of mortality of COVID-19 in patients with a SMI. Somatic factors linked to increased risk of death from COVID-19 were severe obesity, diabetes, severe asthma, respiratory disease, chronic heart disease, liver disease, stroke, dementia, other neurological diseases, reduced kidney function and autoimmune diseases [11]. A majority of these diseases or conditions is more prevalent in people with SMI than in the general population [12]. Hence, it is highly pertinent to reduce the risk of infection in this population before effective protection through vaccination can be established.

However, findings related to the risk of being infected with the SARS-CoV-2 in people with SMI vary. In a nationwide study from the US of all persons with a recent mental illness diagnosis, persons with depression and schizophrenia were found to have adjusted odds ratios above 7 for contracting SARS-CoV-2 infection compared to the general population [13]. In contrast to these results, in a large study from Israel (total *n* = 51,078), people with schizophrenia had lower prevalence of COVID-19 compared to age- and sex-matched controls [14]. Also in a Danish study [15], lower

seroprevalence of SARS-CoV-2 antibodies was found in patients with schizophrenia, schizoaffective disorder or bipolar disorders compared to unvaccinated blood donors. These findings corroborate the results in a study from England that showed lower prevalence of positive COVID-19 tests in people with SMI compared to people without a psychiatric history [16]. SARS-CoV-2 spreads primarily by face-to face contact via respiratory droplets [17] and social distancing reduces disease transmission [18]. Housing is a determinator of social contact and thus also for the risk of transmission of SARS-CoV-2 [19]. The proportion of positive cases from household transmission was between 20% and 45% in a study from Denmark [20], while a Norwegian study found a 45% overall household attack rate measuring seroconversion [21]. In line with this, congregational living has been found to increase the risk of transmission of SARS-CoV-2 [22]. Also workplace transmission of SARS-CoV-2 has been highlighted and a meta-analysis of non-pharmaceutical interventions across countries showed an effect of workplace closure [23].

The present study aimed to investigate the seroprevalence of SARS-CoV-2 antibodies, prevalence of somatic conditions with elevated risk for serious course of COVID-19 and social factors (housing and income sources) in acutely admitted psychiatric inpatients in a large psychiatric emergency department during the early months of the SARS-CoV-2 pandemic.

## 2. Methods

The protocol for the Psychiatric Acute Department (PAM) COVID-19 (PAMCOV) study is based on 'Population-based age-stratified seroepidemiological investigation protocol for COVID-19 virus infection' downloaded on 24 April 2020 from WHO, now accessible at https://www.who.int/publications/i/item/WHO-2019-nCoV-Seroepidemiology-2020.2. The contextual frame for the study with respect to testing for SARS-CoV-2 and positive tests in the catchment area of Haukeland University Hospital is shown in Figure 1.
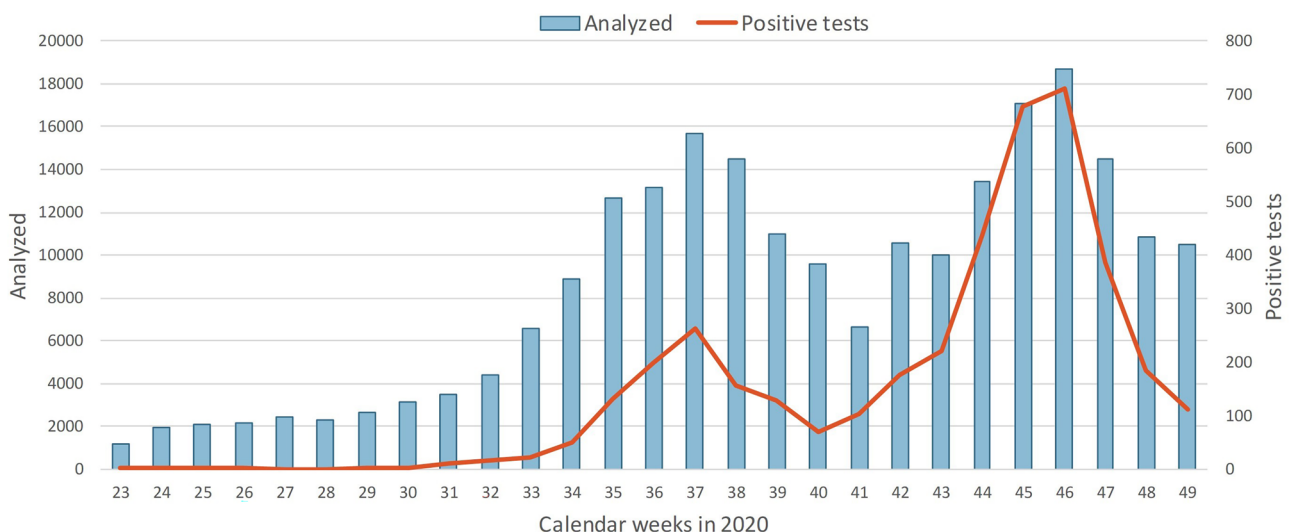


Figure 1. Analysed (blue bars) and positive (brown line) polymerase chain reaction (PCR) based SARS-CoV-2 tests in the geographical area of Haukeland University hospital in week 23 through 49 in 2020.

## 2.1. Study design

The PAMCOV study is a cross-sectional prospective sero-epidemiological investigation for COVID-19 virus infection, also including clinical data collected from the patients at admission to hospital.

## 2.2. Study population – eligibility – recruitment

All patients admitted through the PAM, Psychiatric Clinic, Haukeland University Hospital from 2 June 2020 (week 23) to 31 August 2020 (week 36) and 01 October 2020 (week 40) to 30 November 2020 (week 49), irrespective of age, sex or comorbid conditions, were eligible to the study. Ethical approval to include SARS-CoV-2 serology in the standard blood tests at admission and for inviting patients to participate in the study when they were evaluated as competent to give informed consent to participate, was obtained from the Regional Committee for Medical and Health Research Ethics in Western Norway (reference number 2020/140046). Patients admitted during the inclusion periods but not invited due to mental state or for practical reasons, were invited by letter during 14 January 2021 to 10 February 2021 to participate by returning a signed informed consent. Patients with

contraindications to venipuncture could not be included in the study. See Figure 2 for flowchart of eligibility and inclusion.

During the study period, 601 patients had a total of 893 eligible admissions (see Figure 2), and 245 patients consented to participate during their hospital stay. In a total of 367 admissions, the patients were not invited to participate in the study before discharge, for 85 admissions owing to lack of blood tests being drawn, for 23 admissions due to questions related to the competence to consent, and for two cases owing to lack of a postal address. One hundred and sixty-five of the discharged patients were invited to participate during subsequent admissions or had declined participation at a previous admission. Thus, 92 patients were contacted by letter, of which 21 accepted participation. This gave us a total of 266 patients included, with a total of 311 admissions.

## 2.3. Data collection

*Questionnaire from the WHO protocol.* Participants completed a questionnaire on symptoms and demographic information (https://www.who.int/publications/i/item/WHO-2019-nCoV-Seroepidemiology-2020.2) (for further details see Table 1).
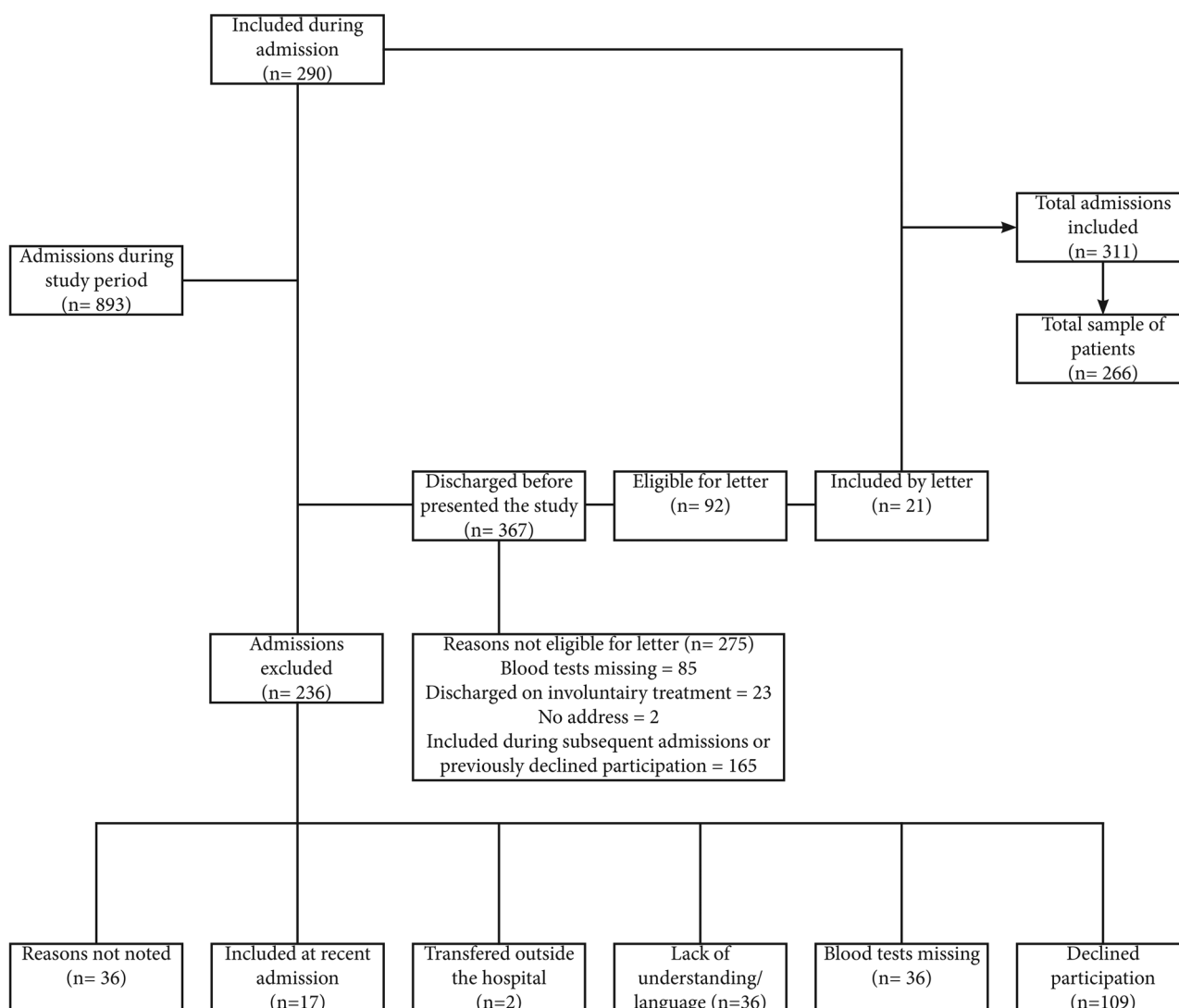


**Figure 2.** Flowchart of the PAMCOV study.

**Table 1.** Baseline characteristics for patients included in the PAMCOV study (n = 266).

|  | Mean (SD) | n (%) |
|---|---|---|
| Age | 38.7 (16.4) |  |
| Gender (male) |  | 136 (51.3) |
| Main diagnostic categories |  |  |
| Substance use disorders (ICD 10 F10–19) |  | 76 (28.6) |
| Schizophrenia spectrum disorders (ICD 10 F20–29) |  | 58 (21.8) |
| Affective disorders (ICD 10 F30–39) |  | 90 (33.8) |
| Anxiety disorders (ICD 10 F40–41) |  | 54 (20.3) |
| Personality disorders (ICD 10 F60–61) |  | 42 (15.8) |
| Increased risk of serious COVID-19 infection due to |  |  |
| One somatic condition |  | 48 (18.5) |
| Two somatic conditions |  | 15 (5.6) |
| Three somatic conditions |  | 3 (1.2) |
| Laboratory characteristics |  |  |
| CRP (n = 258), mg/l | 4.7 (12.0) |  |
| LPK (n = 260), ×10⁹/l | 7.3 (2.4) |  |
| SARS-CoV-2 IgG positive (n = 248) |  | 2 (0.8) |
| SARS-CoV-2 PCR test during admission |  | 30 (11.3) |

n: the number in the total sample is 266 unless otherwise specified.

*Information from medical records.* The following variables were acquired from the medical records: age, sex, psychiatric and somatic diagnosis, COVID-19 polymerase chain reaction (PCR) test, C-reactive protein (CRP) white cell count (LPK). Somatic diagnoses were recorded based on the specific somatic conditions listed as risk factors for having a serious course of COVID-19 from the Norwegian Institute of Public health (www.fhi.no): chronic cardiovascular disease (except well treated hypertension), obesity (BMI > 35), diabetes mellitus, chronic kidney disease, chronic pulmonary disease (except well treated asthma), chronic liver disease, other immune suppressing diseases or treatment. During the COVID-19 pandemic, all patients were screened by a nurse or physician at admission to hospital with a pre-triage form covering core symptoms of COVID-19 and clinical evaluation. Information entered in the pre-triage form was also acquired from the medical journal.

## 2.4. Specimen collection and transport

A serum sample was collected from all patients upon admittance to the PAM along with the standard blood tests at admission. For the analysis of COVID-19, one 5 ml vacutainer was drawn in addition to the other serum samples collected. The preparation and transport of the specimen followed regular requirements for serum samples from the Psychiatric Clinic to the Department of Microbiology, Haukeland University Hospital.

## 2.5. Serological analysis

Serum samples were routinely analysed for specific IgG antibodies against SARS-CoV-2 with one of three assays according to manufacturers' protocols. The LIAISON® SARS-CoV-2 S1/S2 IgG (DiaSorin, Saluggia, Italy) uses chemiluminescence immunoassay technology for the determination of anti-S1 and anti-S2 specific IgG antibodies. The anti-SARS-CoV-2 ELISA (IgG) (EuroImmun, Lubeck, Germany) detects structural proteins, and the EDI™ Novel Coronavirus COVID-19 IgG ELISA kit (Epitope Diagnostics, Inc., San Diego, CA) detects nucleocapsid protein using enzyme-linked immuno-sorbent assay technology. Results are reported semi-quantitatively as positive, equivocal or negative.

### 2.5.1. Risks and benefits for subjects

The investigation posed minimal risk to the participants, as it involved only one extra serum tube at admittance, as well as a brief self-registration form. The primary benefit of the study was at the group level as the data provided knowledge about prevalence and clinical manifestations of the SARS-CoV-2 infection in a population that may require special prevention and clinical efforts. The clinicians responsible for the clinical treatment of the participants received information about the results of the serological investigation. The participants received a gift voucher with value 200 NOK as compensation for time spent in participating in PAMCOV.

### 2.5.2. Prevention of COVID-19 virus infection in the investigating personnel

All personnel involved in the investigation were hospital employees and received standard training in infection prevention and control procedures (standard contact and droplet precautions, as determined by national or local guidelines). These procedures included proper hand hygiene and the correct use of protective masks, and clothing as indicated by the hospital regulations for the COVID-19 pandemic.

## 2.6. Statistical analyses

### 2.6.1. Sample size calculations

The PAM receives around 200 admissions each month, and the study was presumed to obtain informed consent from around 75% of admitted patients. Consequently, a 6 months study could assume to include around 900 admissions for around 600 unique patients.

### 2.6.2. Analyses

We used IBM SPSS version 26.0 (Armonk, NY) to analyse the data. The level of statistical significance was set at $\alpha = 0.05$, two-tailed. Descriptive analysis included mean and frequencies. Bivariate relations were analysed by correlations, crosstabs and t-tests. Generalized estimating equations (GEEs) were used to deal with potential clustering in the variables due to the fact that patients could have more than one admission during the study period.

## 2.7. Prevalence of COVID-19 in Norway at the end of the study period

We retrieved the number of reported cases (n = 33,019) of COVID-19 by 30 November 2020 from the website of the Norwegian Institute of Public Health (www.fhi.no), and the Norwegian population by 1 January 2021 (n = 5,391,369), from the website of Statistics Norway (www.ssb.no). The calculated prevalence at the end of the study period was 33,019/5,391,369 = 0.61%.

## 3. Results

### 3.1. Descriptives

The mean age of the 266 included participants was 38.7 years (range 18–96 years) and 51.3% of the patients were male. Patient characteristics are shown in Table 1. We found no significant

**Table 2.** Participant response to the WHO protocol.

| | Have you now, or have you had these symptoms after 1 February 2020? (%) | | | |
|---|---|---|---|---|
| | YES, I have this symptom now | I do not have this symptom now, but I have had this symptom after 1 February 2020 | NO, I do not have this symptom now, and I have NOT had this symptom after 1 February 2020 | Unknown/not accessible |
| Fever ≥38 °C | 0.0 | 15.3 | 80.8 | 3.9 |
| Chills | 3.5 | 34.8 | 59.2 | 2.3 |
| Fatigue | 17.0 | 30.9 | 50.7 | 1.4 |
| Muscle ache (myalgia) | 10.6 | 19.5 | 69.5 | 0.4 |
| Sore throat | 2.8 | 28.7 | 67.7 | 0.7 |
| Cough | 4.3 | 24.8 | 70.6 | 0.4 |
| Runny nose (rhinorrhea) | 7.4 | 28.0 | 63.8 | 0.7 |
| Shortness of breath (dyspnea) | 6.8 | 23.1 | 69.8 | 0.4 |
| Wheezing | 4.3 | 16.7 | 78.3 | 0.7 |
| Chest pain | 3.6 | 18.5 | 77.2 | 0.7 |
| Other respiratory symptoms | 1.8 | 7.5 | 89.0 | 1.8 |
| Headache | 8.5 | 39.1 | 52.3 | 0.0 |
| Nausea/vomiting | 4.3 | 28.8 | 66.2 | 0.7 |
| Abdominal pain | 4.6 | 25.3 | 69.4 | 0.7 |
| Diarrhoea | 4.6 | 27.8 | 67.3 | 0.4 |
| | Yes | | No | |
| Did any of these symptoms require you to seek medical attention? | 22.1 | | 77.9 | |
| Did any of these symptoms require you to miss work or school? | 12.9 | | 87.1 | |
| Did any of these symptoms require you to be hospitalized? | 6.1 | | 93.9 | |
| Source of income last 3 months (%) | | | | |
| Salary | | 20.1 | | |
| Disability benefit | | 40.6 | | |
| Age pension | | 6.5 | | |
| Social benefit | | 5.8 | | |
| Work assessment allowance | | 15.5 | | |
| Provided for | | 2.9 | | |
| Other | | 8.6 | | |
| Number of people in the household including you (%) | | | | |
| 1 | | 57.0 | | |
| 2 | | 19.0 | | |
| 3 | | 10.8 | | |
| 4 | | 6.8 | | |
| 5 | | 3.6 | | |
| 6 | | 1.1 | | |
| >6 | | 0.8 | | |

**Table 3.** Somatic diseases within diagnosis categories.

| Somatic diseases | n (%) |
|---|---|
| Chronic cardiovascular disease, except well treated hypertension | 22 (8.2) |
| Obesity (BMI > 35) | 7 (2.7) |
| Diabetes mellitus | 20 (7.5) |
| Chronic kidney disease | 1 (0.4) |
| Chronic pulmonary disease, except well treated asthma | 18 (6.5) |
| Chronic liver disease | 3 (1.2) |
| Other immune suppressing diseases or treatment | 16 (6.2) |
| No known somatic disease | 195 (75) |

differences in patient characteristics between those included during hospitalisation and those included by letter.

### 3.2. Somatic risk factors

In 75% of the included patients, no somatic disease/condition or ongoing treatment was detected that could potentially increase the risk of serious course of COVID-19. The frequency of somatic diseases is shown in Table 2. Furthermore, the distribution of somatic risk factors within the diagnostic categories is shown in Table 3. The highest load of somatic risk factors was found among those having an affective disorder; however, there were no significant differences between those

having an affective disorder compared to those not having an affective disorder (t-test: −1.544, $p = .125$).

### 3.3. Somatic symptoms

Chills, fatigue and headache were the most common symptoms reported. Table 1 shows more details on symptoms assessed by the WHO protocol.

### 3.4. SARS-CoV-2 IgG

Two patients had detectable antibodies after COVID-19 infection, one male and one female, giving a prevalence of 2/266 = 0.75% (binominal 95% confidence interval (CI) 0.09–2.69%). Both were middle aged and admitted due to affective disorders. One of them had somatic risk factors that would increase risk of serious course of COVID-19. They were admitted three months apart. The IgG test was missing for 26 of 311 admissions.

### 3.5. Prediction of SARS-CoV-2 PCR test during admission

The administration of a SARS-CoV-2 PCR test was predicted by the total score on the COVID pretriage at admission

**Table 4.** Somatic illnesses with risk for serious COVID-19 course at index admission (*n* = 266).

| | Substance use[a] (*n* = 76) | Schizophrenia spectrum[b] (*n* = 58) | Affective disorder[c] (*n* = 90) | Anxiety[d] (*n* = 54) | Personality disorder[e] (*n* = 42) |
|---|---|---|---|---|---|
| Coronary disease | 6 | 6 | 7 | 5 | 3 |
| Obesity class 2/3 (BMI > 35) | 2 | 1 | 3 | 1 | 3 |
| Diabetes mellitus | 4 | 6 | 11 | 1 | 2 |
| Chronic kidney disease | 0 | 1 | 0 | 0 | 0 |
| Chronic pulmonary disease, except well treated asthma | 5 | 2 | 8 | 3 | 2 |
| Chronic liver disease | 2 | 1 | 0 | 0 | 1 |
| Other immune suppressing diseases or treatment | 4 | 2 | 9 | 3 | 2 |
| Total | 23 (30.3%) | 19 (32.8%) | 38 (42.2%) | 13 (24.1%) | 13 (31.0%) |

Other immune suppressing diseases or treatment: use of prednisolone or cancer treatment. Based on first/index admission in the study period, one or more diagnoses within a diagnosis category.
[a]ICD 10 F10–19.
[b]ICD 10 F20–29.
[c]ICD 10 F30–39.
[d]ICD 10 F40–41.
[e]ICD 10 F60–61.

(*b* = .701, *p* = .050, Exp (*B*) = 2.027, CI: 1.236–3.325). CRP levels did not predict PCR test (*b* = .022, *p* = .175, Exp (*B*) = 1.022, CI: .990–1.055).

## 4. Discussion

The main finding in this study indicates that the governmental and municipal restrictions established from the 12 March 2020 and onwards in Norway established a strong protection against SARS-CoV-2 infection for people in need of psychiatric treatment compared to many other areas of the world. Analyses of SARS-CoV-2 IgG antibodies in the 266 acutely admitted psychiatric inpatients with a total of 311 admissions studied during the initial months of the COVID-19 pandemic showed a prevalence of 0.75% (95% CI: 0.9–2.69%) of the patients with a positive test. Contrary to what was expected at the outbreak of the pandemic, the spread of SARS-CoV-2 in the population of acutely admitted psychiatric patients was low, and comparable to the cumulative prevalence in the general population of Norway in the same time period, which was 0.61%. However, our small sample of patients with IgG antibodies give room for a large uncertainty, and it is conceivable that other samples drawn from the population of psychiatric patients in Norway could have shown higher prevalence. Findings from China and U.S.A. show that patients with serious mental diseases were found to have a significantly higher incidence of infection with SARS-CoV-2 compared to the general population [7,8,13]. A study of inpatients from two New York hospitals performed in the first two months of the pandemic found 15.6% of tested patients to have a positive SARS-CoV-2 PCR test, a majority of these patients were asymptomatic [24]. The low cumulative incidence in our material is, however, in accordance with findings from Denmark, England and Israel of a lower cumulative incidence in people with mental health problems compared to the general population [9, 14–16]. Several factors may have contributed to a low spread of virus in the Norwegian population of patients with psychiatric disorders. A national report from the Norwegian Resource Center for Community Mental Health (NAPHA) concerning the municipal services in the first part of the COVID-19 pandemic shows that several measures were established shortly after the outbreak to restrict person-to-person contact: social activity centers/meeting points and supported work were closed, and the personal follow-up of the patients was in most cases done by telephone calls or internet communication [25]. Also, a national governmental report shows a 6% reduction only in psychiatric inpatients stays in Norway between 2019 and 2020, compared to a 17% reduction in a group of 18 EU countries [26]. The low cumulative incidence of antibodies to SARS-CoV-2 in this study may also have been influenced by the pattern of housing sizes found in our material: with 57% living alone, compared to 18% living alone in the Norwegian general population (ssb.no), and furthermore that additional 19% lived with only one additional person. Given the high number of secondary cases in primary care house-holds [20,21], a low prevalence of cohabitation may have influenced the relative risk of being infected in our sample related to the general population. The low seroprevalence of antibodies to SARS-CoV-2 in Denmark for people with SMI has been linked to low prevalence of homelessness in people with SMI compared to what is found in some other countries. A study of homeless people in Denmark shows doubled level of SARS-CoV-2 antibodies compared to geographically matched blood donors [27]. Also in Norway, the prevalence of homelessness among patients with SMI is low and falling [28]. Moreover, the participants in our study had low work force participation, as only 20% of the participants had ordinary salary (not paid by the Norwegian Labour and Welfare Administration) as their main income. This would further enhance the patients' social distancing. To sum up: the combination of a continuation of psychiatric hospital capacity and rapidly implemented municipal restrictions in a population of patients with low levels of cohabitation and low work force participation may have been protective. Also, a qualitative study from Norway showed that a high portion of the informants with concurrent mental health and substance use disorders started a self-imposed quarantine during the first weeks of the lock-down, which may also have contributed to low spread of SARS-CoV-2 in this population [29]. Furthermore, more coincidental factors related to the initial spread of the SARS-CoV-2 in the Norwegian population could be contributing, for example, that the early widespread infections with

SARS-CoV-2 transmitted by skiing tourists returning from European resorts [30] induced early national alertness in Norway with rapid detection and implementation of preventive measures that reduced spread of the SARS-CoV-2 into the population of people with SMI.

The prevalence of positive screening responses as recorded by the WHO pretriage form ranged from 0% (fever above 38.0 °C) to 17% (fatigue) at admission, while the portions having had positive screening responses items since the advent of the pandemic were as high as 39.1% for headache, chills 34.8%, rhinorrhea 28.0%, dyspnea 23.1%, and 15.3% had gone through a period with fever above 38.0%. Furthermore, 11.3% of the included patients were suspected to be infected with SARS-CoV-2 and thus had a PCR test performed, with none of the patients showing a positive PCR test. A positive screening predicted that a PCR test was performed. The high prevalence of positive screening items illustrates the problems of early identification of a SARS-CoV-2 infection based on symptoms in low-prevalence populations where other infections and conditions with similar symptoms and signs are prevalent.

Around 25% of the admitted patients had somatic conditions that could elevate their vulnerability for having a serious course if infected with SARS-CoV-2 according to the Norwegian Institute of Public Health, with cardiac disease (8.2%), diabetes mellitus (7.5%) and lung diseases (6.5%) as the most prevalent conditions. Serious obesity with a BMI above 35 was found in 2.7% of patients, and corresponds to the findings from a systematic review by Afzal et al. [31], showing that patients with SMI in Norway may have lower prevalence of obesity than in some other European countries. Patients with affective disorders had the highest prevalence (42.2%) of somatic risk factors for a more serious course of COVID-19 followed by schizophrenia spectrum disorders (32.8%), illustrating that people with SMI has increased risk for a serious course of COVID-19 once infected. Specific emphasis on obtaining high levels of vaccination in this population is thus warranted, and prioritizing these patient groups for vaccination in settings with low access to vaccines may be justified [32].

## 5. Limitations

There are some limitation to this study. First, for a number of reasons we were not able to include approximately 65% of the patients admitted in the inclusion periods. Although, we were granted ethical permission to use representative consent this was not easy to undertake and it is probable that patients with higher symptom burdens were less likely to be included in the study. Second, the categorization of the somatic risk factors were based on data obtained from the patients' electronic medical records, which can be less accurate in psychiatric acute admissions given the limited access to information. In this respect, we strongly suspect that the recorded numbers of somatic disorders are minimum numbers, and that the true prevalence is higher. Moreover, due to the low numbers of seropositive patients among the participants, the uncertainty of our main outcome is considerable, as already mentioned.

## 6. Conclusion

In this survey of acutely admitted psychiatric patients covering a significant period of the first year of the SARS-CoV-2 pandemic in Norway, we found high scores on many of the items on the WHO pretriage form, high prevalence of somatic risk factors for a more serious course of the COVID-19 and a low prevalence of antibodies to SARS-CoV-2. The prevalence of antibodies to SARS-CoV-2 was comparable to the prevalence in the Norwegian general population in the time period where the study was performed; however, the estimate has a broad CI.

## Author contributions

RAK, AJL and EJ planned and conducted the study. LAS conducted the data analyses and prepared the tables. HMSG and EU contributed in planning of the study and were responsible for the laboratory analyses and evaluations. RAK and LAS drafted the manuscript, all authors contributed, reviewed and approved the final manuscript.

## Ethical approval

The Regional Committee for Medical and Health Research Ethics ethical board authority approved that PAMCOV could collect a delayed informed consent because of the acute setting in which this study was conducted.

## Patient consent

Patients admitted to the Psychiatric Clinic were approached after the acute situation at admission was resolved and invited to participate in the PAMCOV project, and all participants consented to participate. A proportion of patients admitted to the Psychiatric Clinic has a reduced capacity to provide a consent for participation in the PAMCOV study. The Regional Committee for Medical and Health Research Ethics gave approval for the PAMCOV study to approach the patient's next of kin or the patient's legal guardian and ask them to provide consent on behalf of the patient.

## Disclosure statement

The authors declare that they have no competing interests.

## Notes on contributors

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## Funding

## Data availability statement

Data sharing require, according to Norwegian law, approvals from the Data Protection Officer at Haukeland University Hospital and the Regional Committees for Medical and Health Research Ethics on the basis of specific research proposals.

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